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Volume 2, Number 10, May 31, 1977

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The Administrator of the Energy Research and Development Administration has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this agency. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through June 30, 1978.

Volume 2, Number 10, May 31, 1977

ERDA ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

REFER ALSO TO CITATION(S) 24936

23890 **7th international congress for black coal processing.** *Bergbau;* **27**: No. 10, 393-395(Oct 1976). (In German).

From 7. international congress for black coal processing; Sydney, Australia (24 May 1976).

The congress for black coal processing, held in Sydney, is reported on and some results of particularly interesting activities are presented.

23891 **7th international congress for black coal processing.** *Aufbereit.-Tech.;* **17**: No. 10, 539-542(Oct 1976). (In German).

From 7. international congress for black coal processing; Sydney, Australia (24 May 1976).

The congress for black coal processing held in Sydney, is reported on and some results of particularly interesting activities are presented.

PROCESSING

23892 (ORNL/TM—5752) **Coal technology program progress report for November 1976.** (Oak Ridge National Lab., Tenn. (USA)). Jan 1977. Contract W-7405-ENG-26. 41p. Dep. NTIS $4.00.

This report, the 28th of a series, is a compendium of monthly progress reports for the ORNL research and development programs that are in support of the increased utilization of coal as a source of clean energy. The projects reported this month include those for coal conversion process development, materials engineering, alkali metal vapor topping cycles, a Critical Components Test Facility, engineering and support studies, environmental assessment studies, and coal-fueled MIUS.

DESULFURIZATION AND PURIFICATION

REFER ALSO TO CITATION(S) 23912, 23921, 23929, 23938, 23951, 23965

23893 (BNWL—2040-3) **Process for cleaning and removal of sulfur compounds from low Btu fuel gases. Quarterly summary report, July—September 1976.** Moore, R.H.; Ham, D.G.; Stegen, G.E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Oct 1976. Contract E(45-1)-1830. 21p. Dep. NTIS $3.50.

Detailed design of the remodeled PDU is complete insofar as items that have effect on the schedule is concerned. These items include the piping support structure and piping and process vessels or equipment that must be "alonized" for corrosion protection. Major procurements have been initiated. Orders have been placed with low bidders for procurement of the extraction and regeneration columns and for the major portion of the trace heaters needed. The bid package for piping, coarse de-entrainer, salt cooler, venturi feed tank, and venturi (all of which will require "alonizing") has been submitted to the Purchasing Department for distribution to selected vendors. A comprehensive stress analysis on piping and support structures has been conducted with the aid of well known computer codes by personnel from the Engineering Department. Portions of the PDU have been dismantled and some site preparation work has been completed to facilitate impending construction.

23894 (FE—2011-5) **Catalysts for upgrading coal-derived liquids. Quarterly report, June 9, 1976—September 8, 1976.** Crynes, B.L. (Oklahoma State Univ., Stillwater (USA). School of Chemical Engineering). 21 Sep 1976. Contract E(49-18)-2011. 24p. Dep. NTIS $3.50.

Results are shown from one experimental series using raw anthracene oil over an alumina support which had not received active metal species (Co and Mo). Under the maximum conditions tested (750°F, 1500 psig, 1.65 hr), sulfur and nitrogen removal were 47 to 54% and 30 to 39%, respectively. In a similar experimental series, but without hydrogen present, N_2 removal was only 4 to 6% and the S concentrations of the product oils increased over that of the feedstock. The catalyst life test unit is now within 95% completion of construction. The pentane-soluble acid fraction was shown to contain eight molecular weight series. The composition of each of these series is discussed in terms of possible compound types and their distributions. Principal structural types identified in the acid fraction corresponded to benzenes, indanes and indenes substituted with one or two hydroxyl groups on the aromatic nucleus. This fraction is composed primarily of 2- and 3-ring aromatic hydrocarbons. High-resolution mass spectrometry was used to identify the presence of several "doublets" corresponding to the presence of both ethers and hydrocarbons for respective compound classes. Preliminary analysis of the pentane-soluble bases is discussed in terms of qualitative data obtained from both 70 eV high-resolution EI and low resolution FI mass spectrometry.

23895 (ORNL-tr—4296) **Electrochemical studies on pressure leaching. Part 3. Studies on pressure leaching of pyrites.** Nagai, T.; Kiuchi, H. Translated by H. Kubota from *Nippon Kogyo Kaishi;* **91**: No. 1050, 547-553(1975). 14p. Dep. NTIS $3.50.

Electrochemical measurements were performed in an autoclave to follow the reaction mechanism of the pressure leaching of pyrites. It was indicated that the reactions taking place during anodic polarization at high temperature correspond to reactions taking place during pressure leaching, and the reaction mechanism for pressure leaching can be thought to incorporate electrochemical processes.

23896 **Method to reduce the pyrite sulfur content in coal.** Meyers, R.A. (to TRW, Inc., Redondo Beach). German(FRG) Patent 2,207,491/C/. 2 Jan 1976. 5p. (In German).

1 fig. Available from Dt. Patentamt, Muenchen (FRG).

According to the invention, a method is suggested to reduce the pyrite sulfur content in coal by treating the coal with an aqueous solution. The method is thus characterized in that the coal is treated with an aqueous solution containing iron(III) ions in order to give free sulfur and a solution containing iron(II) ions. This solution is then separated off from the treated coal and the sulfur is removed from the coal.

23897 **Method to remove hydrogen sulphide from coke oven gas.** Weber, H.; Tippmer, K. (to Still (C.)). German(FRG) Patent 1,494,815/C/. 28 Aug 1976. 4p. (In German).

1 fig. Available from Dt. Patentamt, Muenchen (FRG).

The method proposed here works according to the ammonia-hydrogen sulfide cycle process. Different from already known processes, in addition to the ammonium hydroxide introduced into the cycle on the lower part of the column, one also adds here gaseous ammonia at several positions in the upper part of the column. In addition, extensively deacidified ammonia clouds from the distilling column are added which are introduced directly over the filling sections of the upper part of the H_2S washing column at a temperature of 40-45°C.

HYDROGENATION

REFER ALSO TO CITATION(S) 23924, 23926, 23932, 23933, 23934, 23935

GASIFICATION

REFER ALSO TO CITATION(S) 23955, 24030, 25215

23898 **Gas from coal.** Warren, I.H. (Univ. of British Columbia, Vancouver). *Coal Miner;* **1**: No. 2, C21-C23(Jun 1976).

The internal consumption of natural gas in British Columbia is about 0.13-trillion cubic feet per year, equivalent to 1.5 unit-size gasification plants. Thus, in magnitude of undertaking, supply of substitute natural gas sufficient to satisfy the total Provincial use would not be unthinkable. However, particularly the latter option considered above should be given serious attention in British Columbia, since, apart from the Hat Creek deposit, it appears that the Province's coal reserves are mostly of medium to good coking quality. The total supply of gas for provincial use could be provided as a byproduct from the carbonizing of about 25-million tons/yr of coal.

23899 (CONF-760585—1) **Prospects for coal gasification: then and now.** Linden, H.R. (Institute of Gas Technology, Chicago, Ill. (USA)). 1976. 12p. Inst. of Gas Technology, Chicago.

From International petroleum exposition and congress; Tulsa, Oklahoma, United States of America (USA) (17 May 1976).

Plans for coal gasification during the period 1971 to 1975 are discussed as well as the failure to meet goals established at the beginning of the period. Graphs are used to show: announced commercial high-Btu coal gasification plants and expansions (Lurgi gasification with methanation); U.S. energy supply in 1985; world crude oil reserves and life index; case histories of investment cost escalation; comparison of coal-based residential space heating; and 1975 cost estimates and conversion efficiency of synthetic fuels from coal. (EJH)

23900 (CONF-761008—6) **Areal sweep efficiency of the in-situ recovery of subbituminous coal.** Jennings, J.W.; Gunn, R.D.; Brandenburg, C.F.; Whitman, D.L. (Texas Agricultural and Mechanical Univ., College Station (USA); Energy Research and Development Administration, Laramie, Wyo. (USA). Laramie Energy Research Center; Wyoming Univ., Laramie (USA)). 1976. 8p. Society of Petroleum Engineers of AIME, Dallas, TX.

From 51. annual meeting of the Society of Petroleum Engineers; New Orleans, Louisiana, United States of America (USA) (3 Oct 1976).

The results are presented of applying particle tracking techniques to the prediction of areal sweep for the in-situ recovery of subbituminous coal. Comparison of field data with calculated values indicates that these techniques are applicable and support the theory that the in-situ recovery of subbituminous coal as encountered at Hanna, Wyoming, is a permeation process. The model predicts breakthrough of the flame front at the production well and intermediate points with sufficient accuracy for preliminary design purposes.

23901 (CONF-761016—5) **HYGAS Process development.** Anastasia, L.J.; Bair, W.G. (Institute of Gas Technology, Chicago, Ill. (USA)). 1976. Contract E(49-18)-2434. 8p. Dep. NTIS $3.50.

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976).

The HYGAS Process is a high-temperature, high-pressure, fluidized-bed process designed to maximize production of methane gas from all types of coal as a supplement to America's gas supplies. The Institute of Gas Technology conceived the process and the U.S. Energy Research and Development Administration and the American Gas Association are currently funding it. Experimental process development is proceeding in a pilot plant which feeds 3 tons/hr of coal to produce a nominal 1.5 X 10^6 ft^3 of pipeline-quality gas per day. Development studies using a Montana lignite containing 1 percent S have been completed. The gasification of Illinois No. 6 bituminous (ca.3 percent S) coal has been demonstrated and current work is directed toward gasification of a subbituminous coal from the Rosebud seam.

23902 (CONF-761064—4) **Status of the HYGAS program.** Lee, B.S. (Institute of Gas Technology, Chicago, Ill. (USA)). 1976. Contract E(49-18)-2434. 20p. Dep. NTIS $3.50.

From 8. synthetic pipeline gas symposium; Chicago, Illinois, United States of America (USA) (18 Oct 1976).

The significant achievements in the continuing development of the HYGAS Process by the Institute of Gas Technology since the last Synthetic Pipeline Gas Symposium in October 1975 are recounted. During this year the following milestones were reached in the HYGAS program: (1) the pretreatment section produced suitable feed to the gasifier from a highly caking bituminous coal during sustained operation; (2) the technical feasibility of operating the integrated HYGAS-Steam/Oxygen gasification system was demonstrated in extended self-sustained operation using highly caking bituminous coal as a feed; and (3) gasification tests with Montana Rosebud seam subbituminous coal were begun in September 1976.

23903 (CONF-761104—1) **Further studies of fast fluidization.** Cankurt, N.T.; Yerushalmi, J. (City Coll., New York (USA). Dept. of Chemical Engineering). 16 Nov 1976. Contract E(49-18)-2340. 33p. Dep. NTIS $4.00.

From Conference on mathematical modeling of coal conversion processing; Washington, District of Columbia, United States of America (USA) (16 Nov 1976).

As a gasifier, the fast bed offers several advantages. Several factors may contribute to high gasification rates per unit bed volume: The fast bed affords contact with surprisingly large inventory of solid per unit bed volume, gas-solid contacting is expected to be excellent, and gas flow to approach a condition of plug flow. These and the relatively high gas velocities that are typical to the fast bed ought to afford large coal-processing throughputs per unit cross-sectional area of the bed. Two other important advantages should be mentioned: The fast bed may be able to receive directly a caking coal without pretreatment and by injecting the feed coal near the bottom of the fast bed, the breakthrough of tars can be prevented, provided the temperature of the bed lies above about 1700°F.

23904 (CONF-761109—6) **Gasification of coal chars in a fluidized-bed ash-agglomeration gasifier.** Saadstrom, W.A.; Rehmat, A.G.; Bair, W.G. (Institute of Gas Technology, Chicago, Ill. (USA)). Nov 1976. Contract E(49-18)-2434. 23p. Dep. NTIS $3.50.

From 69. annual meeting of the AICHE; Chicago, Illinois, United States of America (USA) (28 Nov 1976).

The objective of the program was to study the ash-agglomeration principle, to design and construct an atmospheric pressure pilot plant, and to obtain experimental data from this unit. An ash-agglomeration gasifier was built 4 ft. in diameter by 25 ft. high with a nominal capacity of 500 lb./hr. of feed material. The gasification mediums utilized were air and steam, enriched air and steam and oxygen/steam mixtures. The basic objectives of the test program were achieved when processing metallurgical coke. These objectives were (1) the selective removal of high-ash-bearing material while operating with a high-carbon-content fluidized bed, (2) the reinjection and combustion of elutriated fines from the fluidized-bed gasifier, and (3) conversion of greater than 95 percent of the carbon fed to a fuel gas. The results of this test program are highly encouraging. Additional work at higher pressures should be done to confirm the design factors to incorporate the ash-agglomeration gasifier process into a high-pressure coal gasification process, such as HYGAS.

23905 **Coal: gasification.** *Mosaic;* **5**: No. 2, 29-30(Spr 1974).

A fast fluidized bed process for coal gasification is described, in which particles in the gas are separated in a cyclone separator and returned to the reactor. By using high temperatures the production of tars and other undesirable products is minimized. Also, the amount of steam required is reduced and it is converted almost entirely to hydrogen and carbon monoxide. With a combined cycle power plant and advanced turbine design, a conversion efficiency of 50 percent is expected. Alternatively methane and other hydrocarbons could be produced. Air pollution would be minimized: sulfur and fly ash would be converted to hydrogen sulfide and scavenged in a calcined dolomite filter. Sulfur would be recovered. (LTN)

23906 (CONF-7510150—1) **Technology and environmental impact of coal gasification processes.** Fleming, D.K. (Institute of Gas Technology, Chicago, Ill. (USA)). 1975. 23p. Institute of Gas Technology, Chicago, IL.

From Energy development and environment seminar; Schiller Park, Illinois, United States of America (USA) (16 Oct 1975).

Exponentially increasing requirements for new energy in the U. S. can be anticipated. Our energy reserves, however, are limited. Even with maximum expansion of nuclear power generation and other energy from non-conventional sources, we must rely heavily upon our coal reserves through the end of this century. Gasification of coal appears to be a logical and environmentally satisfactory use of that resource. Several technologies for coal gasification either exist or are emerging. In general, coal gasification is divided into three areas: (1) low-Btu gas for direct combustion, (2) intermediate-Btu gas produced as a synthesis gas for coal-chemical manufacture, and (3) high-Btu gas production. In general, the purification requirements for the second and third classes of coal gasification are similar and should result in minimal degradation to the environment, perhaps an order of magnitude less than production of the same quantity of energy in the form of electricity in accordance with present standards. Purification of low-Btu gas, however, is required for environmental considerations only. These environmental constraints and their influence on process economics suggest that the short-term expected emissions will be similar to the alternative overall system of burning the coal directly with stack-gas desulfurization.

23907 **(FE—1505-8) Liquid phase methanation. Quarterly report, April 1, 1976—June 30, 1976.** (Chem Systems, Inc., New York (USA)). 30 Jun 1976. Contract E(49-18)-1505. 75p. Dep. NTIS $4.50.

All chemical and physical property analyses were completed on the polishing reactor catalyst (CRG-A) samples. All four 1000-hr-duration runs indicated a constant reactor performance throughout. Operations in the large-scale PDU continued through April. Synthesis feed gases having a H_2/CO molar ratio of 1.02 and 1.40 were investigated with and without the direct injection of steam. The effluent gas composition was monitored and found to be consistent in all respects with results obtained in the smaller bench-scale unit. Negotiations were finalized on completing the LPM pilot plant. A detailed evaluation of the LPM/S process was completed. The study

includes a discussion of several coal gasification processes and an arbitrary grouping of processes according to the H_2/CO ratio of the synthesis gas produced in the coal gasifier. The economics of the LPM/S process were developed for two typical cases. The first case was for a synthesis gas feed with a H_2/CO ratio of 2/1 which also contained a substantial quantity of CH_4. The Lurgi and Synthane processes would be typical examples. The second case was for a synthesis gas with a H_2/CO ratio of 1/1 and which contains little CH_4. Process flowsheets, heat and material balances, and equipment specifications were prepared for both cases for a commercial-sized plant producing 250 MMM BTU/D of SNG. The results of the process evaluation demonstrate the economic attractiveness of the LPM/S process in commercial-sized SNG complexes. The LPM/S process can be tailored to fit a wide variety of synthesis gases and system conditions where the feed H_2/CO ratio is less than 3. In all cases, LPM/S operates at lower annual costs than separate shift and methanation processes.

23908 (FE—1548-9) **Experimental and process design study of high rate gasification process. Quarterly technical report No. 9, April—June 1976.** Coates, R.L. (Eyring Research Inst., Provo, Utah (USA)). Aug 1976. Contract E(49-18)-1548. 36p. Dep. NTIS $4.00.

Modifications to the coal feeding system were made. The 1$^3/_8$-in. auger was replaced with dual 1-in. augers and an 8-in. intromitter. The coal lock hopper was installed and successfully tested. A infrared pyrometer was installed to monitor reaction chamber temperatures. Two single nozzle and one dual nozzle coal feed injectors were fabricated and tested. Test data from 42 test runs of the gasifier are presented. Excellent reproducibility and moderately high conversion efficiencies were achieved with one of the single nozzle injectors. Conversion data at 150 psi operating pressure with this injector compare closely with earlier Bureau of Mines data even though the volumetric throughput rates were 2 to 4 times higher. During one run with this injector, the gasifier was operated continuously for eight hours. The dual nozzle injector produced higher conversion efficiency, but was subject to plugging and poor reproducibility. Initial tests with an eastern caking coal were made. There was no indication that the caking properties influence operation of the gasifier. Initial tests were also made with a COED char and with a North Dakota lignite. Feeding difficulties were encountered with these coals. Proposals were received and one firm was selected to conduct a preliminary design and cost study of a pilot plant and a 600 T/D commercial plant.

23909 (FE—1772-24) **Engineering support services clean boiler fuel demonstration plant. Quarterly technical progress report, July 1, 1976—September 30, 1976.** (Dravo Corp., Pittsburgh, Pa. (USA). Chemical Plants Div.). 15 Oct 1976. Contract E(49-18)-1772. 13p. Dep. NTIS $3.50.

Engineering support services provided to ERDA are described briefly: site evaluation survey (completed in 1975); environmental studies; conceptual commercial design; preparation of handbook of gasifiers and gas-treatment systems; technical review of Coalcon reports; and char gasifier design. (EJH)

23910 (FE—1775-6) **Preliminary design services, coal conversion demonstration plants. Research and development report No. 114, quarterly report, July—September 1976.** (Parsons (Ralph M.) Co., Pasadena, Calif. (USA)). Nov 1976. Contract E(49-18)-1775. 28p. Dep. NTIS $4.00.

A brief review of the status of the major active design efforts is given, followed by a more detailed reporting on the progress of individual tasks. During the past quarter draft copies were transmitted to ERDA of the final R and D reports describing the designs/economic evaluations for the Fischer-Tropsch and Oil/Gas plants. A document containing a proposed design basis for the COG design was transmitted to ERDA which directed that this task effort hereafter be referred to as POGO, an acronym for Power, Oil, Gas, and Other. Agreement was reached with ERDA regarding primary elements of the POGO design basis. POGO designs will be developed for the following areas of the U.S.: Eastern Region of the Interior Coal Province, Southern Appalachia, and Rocky Mountain Province. Geological information was obtained from state agencies on coal availability in Southern Appalachian and Rocky Mountain Provinces for mining up to 100,000 tons per day. The Oil/Gas and Fischer-Tropsch R and D draft reports were refined in response to comments received from ERDA. The profitability analysis for these tasks was completed. Additional information was obtained on the subject of liquid/solids and gas/solid separation and coal feeding devices. Ionizer units can agglomerate fines in gas streams with a resulting increase in downstream cyclone efficiency. The study of the environmental factors pertaining to the Oil/Gas plant was completed. A brief summary of results by assigned task is included.

23911 (FE—2240-5) **Factored estimates for western coal commercial concepts. Interim report.** Detman, R. (Braun (C.F.) and Co., Alhambra, Calif. (USA)). Oct 1976. Contract E(49-18)-2240. 122p. Dep. NTIS $5.50.

The Joint Coal Gasification Program of the Energy Research and Development Administration and the American Gas Association was organized to accelerate the development of new processes through the pilot plant stage for producing pipeline gas from coal. There are five processes in the program at various stages of development. Two pilot plants are in operation, the IGT Steam-Oxygen HYGAS and the Conoco CO_2 Acceptor. Two others, BCR BI-GAS and ERDA-PERC Synthane, have been completed and are undergoing final checkout or shakedown. The last, IGT Steam-Iron HYGAS is in the final stages of construction. As evaluation contractor for the program, C.F. Braun and Co. has the responsibility for comparative evaluation of these processes. For comparative evaluation, commercial concept designs have been developed using process data provided by the process development contractors and gas processing technology available from process licensors. The capital and operating costs for each of the commercial concept designs have been estimated using a consistent set of guidelines formulated for this specific purpose. The cost of pipeline gas from each of the processes was computed in accordance with the procedures included in the guidelines, and is compared with the cost of gas from a modified Lurgi process.

23912 (FE—2240-5(App.1)) **Factored estimates for western coal commercial concepts. Technical appendix I. Flow diagrams. Interim report.** Detman, R. (Braun (C.F.) and Co., Alhambra, Calif. (USA)). Oct 1976. Contract E(49-18)-2240. 280p. Dep. NTIS $9.25.

The first section is a general description of the commercial concept designs using Western coal feed including: coal handling and preparation; gasification; raw gas quench; shift conversion; acid gas removal; methanation and drying; effluent treating; sulfur recovery; solids disposal; steam and power; and plant water system. Special features of each individual process are discussed in later sections as follows: IGT Steam-Oxygen Hygas Process; IGT Steam-Iron Hygas Process; Conoco Carbon Dioxide Acceptor Process; BCR Bi-Gas Process; Synthane Process; and Lurgi Process. The major portion of the report consists of tables, drawings, and flowsheets. (EJH)

23913 (FE—2240-5(App.2)) **Factored estimates for Western Coal commercial concepts. Technical appendix II. Engineered equipment descriptions.** Detman, R. (Braun (C.F.) and Co., Alhambra, Calif. (USA)). Oct 1976. Contract E(49-18)-2240. 504p. Dep. NTIS $12.75.

Materials of construction are presented in tabular form for the equipment for the following processes: Steam-Oxygen Hygas; Steam-Iron Hygas; Carbon Dioxide Acceptor; Bi-Gas; Synthane; and Lurgi. Final materials selections for plant construction purposes are a matter of agreement among metallurgist, designer, and vendor, and may differ from those for estimating purposes. To prevent unnecessary restriction in future materials selections, specific alloy designations were avoided and more general terms used to describe the generic class of materials required. (EJH)

23914 (FE—2342-6) **Molten salt coal gasification process development unit. Quarterly technical progress report No. 1, April—June 1976.** (Atomics International Div., Canoga Park, Calif. (USA)). 13 Sep 1976. Contract E(49-18)-2342. 18p. Dep. NTIS $3.50.

Work was initiated on the design of a Molten Salt Coal Gasification (MSCG) Process Development Unit (PDU) to convert one ton of coal/hr to a low-Btu fuel gas at about 1800°F and up to 20 atm pressure. In the MSCG process, the coal is gasified by reaction with air in a pool of molten sodium carbonate. The PDU design includes systems for feeding the coal and sodium carbonate into the gasifier, supplying the air, cooling and burning the product gas, and processing molten salt withdrawn from the gasifier to remove ash and sulfur compounds and regenerate sodium carbonate. The principal effort consisted of preliminary design work on the PDU. Twenty-six preliminary design documents were identified and their preparation approximately 75 percent completed. Test work conducted in support of the design included property measurements on refractories used in the gasifier vessel. In addition, a long-term continuous coal gasification test was initiated in the Atomics International Molten Salt Test Facility. Coal gasification at atmospheric pressure with continuous melt withdrawal was initiated on June 23 and was still in progress at the end of the reporting period.

23915 (TID—27322) **Research program, fiscal year 1975.** Eckard, W.E. (Bureau of Mines, Morgantown, W.Va. (USA). Morgantown Energy Research Center). 1975. 56p. Dep. NTIS $4.50.

This report consists of a program summary and one-page presentations concerning the various processes under the following headings: objective; level of effort; recent accomplishments; proposed work; and cooperation. The processes are grouped under the following main headings: Coal Conversion to High-Btu Gas; Low-Btu Gas/Combined Cycle for Power Generation; Synthetic Oil from Coal; Direct Combustion of Coal; Reclamation of Coal Mine Spoils and Refuse Areas; Environmental Aspects of Energy Processes; Petroleum and Natural Gas Recovery; and Plugging Oil and Gas Wells that Penetrate Mineable Coal Seams. The final section is entitled Publications, Appropriations, Personnel. (EJH)

23916 (UCRL-Trans—11188) **Optimal mining and geological conditions for underground coal-gasification stations.** Buyalov, S.I.

Translated from *Razved. Nedr;* **11**: No. 5, 10-17(1941). 26p. Dep. NTIS $4.00.

In selecting a borehole field for new underground gasification stations the following basic factors should be kept in mind. 1. Coal reserves must support uninterrupted operation of the station for the amortization period of all expensive equipment at the station and must be located, when possible, in a small section of the borehole field. 2. Deposits that are tectonically undisrupted, without large fissures or significant folding, should be selected for a station. 3. Unflooded deposits or deposits with weak inflows of organogenic water are desirable. 4. It is desirable for the coal seams to occur in dense argillaceous rock, and for all surrounding rock to be represented by more or less dense deposits. 5. The desirable thickness of the coal seams is 0.4 to 1.5 m, and the structure of the coal seams should be simple when possible. 6. Coal seams with infusible ash (with a melting point of at least 1200 to 1300°) are extremely convenient for underground gasification. 7. Strata of sandstone and limestone are undesirable in the immediate roof of a coal seam to be gasified. 8. It is undesirable to use gasification deposits with highly contiguous coal seams, just as coal seams with bands of significant thickness are inconvenient for gasification. 9. It is undesirable to locate undergeound gasification stations next to coal mines. 10. It is desirable to hae the territorial borehole field of a station as close as possible to the gas consumer.

23917 (UCRL-Trans—11046) **Spreading of the flushing mass during pneumatic flushing of an inclined channel.** Gerdov, M.A.; Beloshabskaya, E.I.; Grigor'eva, T.V. Translated from *Podzemn. Gazif. Uglei;* No. 3, 43-45(1957). 13p. Dep. NTIS $3.50.

Using the simple method described, it is possible to find, for a uniform sand or for a uniform ground coal-ash slag, at a given moisture content of the material and at a given dip angle for the inclined channel being filled, the direction in which the flushing mass will spread. The reverse problem can also be solved, determining the moisture content at which the flushing mass will spread in a given direction. If the flushing material is ground clay shale, the solution of these problems is much complicated by the presence of a dusty fraction in this material. Combined with moisture, this fraction can form a clay mortar with thixotropic properties.

23918 **H_2O: the limiting reactant in the energy equation.** Manahan, S.E. (Univ. of Missouri, Columbia). *Am. Chem. Soc., Div. Environ. Chem., Prepr.;* **15**: No. 1, 198-200(1975).

From 169. ACS national meeting; Philadelphia, PA, USA (6 Apr 1975).

According to a study supported by the U.S. Department of the Interior, water is the key component of any energy system; domestic energy self-sufficiency can only be attained by the use of coal in the intermediate term of 30 to 50 years; the increased reliance on coal will strain available water supplies; 30 to 40% of the original heat content of coal is lost during the conversion to liquid or gaseous fuels; the primary coal-derived synthetic fuels will be SNG; sulfur-free low-Btu gas, solvent refined coal, low-sulfur liquid boiler fuels, and liquid hydrocarbon fuels including gasoline, diesel fuel, and naphtha; and 100 SNG plants, each producing 250 million cu ft/day SNG, would supply only 5% of the projected U.S. energy demand in 2000 (based on historical growth rates). The water requirements for each plant of this capacity will total 19,600 to 48,900 acre ft/yr depending on the quantity of makeup cooling water required (3 to 7%) and the type of coal used (bituminous, sub-bituminous, of lignite).

23919 **Application of new technologies in converting coal.** Krieb, K. (Steinkohlen-Elektrizitaet A.G. (STEAG), Essen (Germany, F.R.)). *Bergbau;* **27**: No. 6, 207-214(Jun 1976). (In German).

15 figs.; 26 refs.

As introduction the development of the conventional steam power process is described and its limitations shown. One can see an improvement of the thermal efficiency in the fuel cell and gas-steam turbine processes. The use of the fuel cell for direct electricity generation from coal predicts the complete gasification of the coal with oxygen and/or hydrogen and efficiencies of above 40% to maximum 55% are expected. If one wishes to use the gas-steam turbine processes for the electricity generation from coal, then a coal transformation process is first also necessary, where the fluidized bed firing, fixed bed gasification, dust part-gasification, and fluidized bed gasification are named as conversion processes. The region in which the probable coupling efficiency will be for the various coal conversion systems and the total efficiency is determined. A summarizing efficiency comparison of all processes treated is illustrated in a diagram.

23920 **Hydrogasification process.** Kalina, T.; Marshall, H.A. (to Exxon Research and Engineering Co.). US Patent 3,985,519. 12 Oct 1976. Filed date 27 Sep 1974. 24p.

Subdivided carbonaceous feed solids containing volatilizable hydrocarbons are hydrogasified by heating the solids to at least minimum hydrogasification temperature while in dilute phase suspension in a gas containing molecular hydrogen and in contact with subdivided hot solids having a temperature greater than minimum hydrogasification temperature. The feed and hot solids are passed with the hydrogen-containing gas through a transfer line hydrogasification zone having a length which, for the velocity of the solids passage therethrough, limits the residence of the solids therein to the time necessary for devolatilization of the carbonaceous feed solids and for conversion of a predetermined minor proportion of the carbon of the feed solids to methane. Suitably from about one to about 50 mole percent of the carbon in the carbonaceous feed solids is converted to methane. Preferably the hydrogen-containing gas is a synthesis gas produced in a fluidized bed steam gasification reaction zone into which carbonaceous solids from the transfer line hydrogasification zone are charged after the separation therefrom of product gases containing methane.

23921 **Method of power generation via coal gasification and liquid hydrocarbon synthesis.** Egan, C.J. (to Chevron Research Co.). US Patent 3,986,349. 19 Oct 1976. Filed date 15 Sep 1975. 10p.

Disclosed is an integrated process for the generation of power, particularly electrical power, from a solid carbonaceous material. A solid carbonaceous material is gasified to produce a combustible synthesis gas. A first portion of this synthesis gas is contacted with Fischer-Tropsch and hydrogenation catalysts to produce normally liquid hydrocarbons and a second combustible gaseous stream. Portions of the two combustible gaseous streams are combined and combusted and utilized to generate a base-load power output and the liquid hydrocarbons are utilized as a fuel for a gas turbine to produce supplemental power for peak-load demand.

LIQUEFACTION

REFER ALSO TO CITATION(S) 23910, 23918, 23932, 23934, 23950

23922 (FE—1224-66) **Laboratory studies of the conversion of solvent refined lignite to light liquid fuels. Project Lignite: premium fuels from Northern Great Plains lignite. R and D report No. 106, interim report No. 3.** Klabunde, K.J.; Low, J.Y.F. (North Dakota Univ., Grand Forks (USA). Dept. of Chemistry). 16 Jan 1976. Contract E(49-18)-1224. 90p. Dep. NTIS $5.00.

Characterization studies of solvent refined lignite (SRL) and solvent refined coal (SRC), and the results of SRL and SRC conversions to lighter materials are described. The solubilities of SRL were determined in about forty organic solvents, several of which dissolved the SRL completely. The basic nitrogen and phenolic contents in the SRL were determined by potentiometric titrations. Some of the nitrogen in SRL comes from the solvent used in its preparation. From spectral studies, elemental analyses, and molecular weight determinations, some structural features of the average SRL molecule were deduced. Approximately 90 hydrogenation experiments were conducted for SRL and SRC conversion to gas and distillable liquid products using a standard set of reaction conditions for catalyst screening. Optimum conditions seemed to be 450°C with initial hydrogen pressures of 1800 psi for non-solvent reactions and 2500 psi with solvent. The best catalyst, in terms of overall conversion and denitrogenation, was presulfided Ni-Mo-Al_2O_3 which gave approximately 90 percent conversion of SRL to 10 percent gases and 80 percent distillable liquids. Almost equally high conversion was obtained with SRC using the same reaction conditions.

23923 (FE—1544-19) **H-Coal Integrated Pilot Plant. Quarterly progress report No. 19. Technical progress report, July—September 1975.** (Hydrocarbon Research, Inc., Trenton, N.J. (USA)). 1975. Contract E(49-18)-1544. 158p. Dep. NTIS $6.75.

Process Development Unit runs for the H-Coal Process 130-70, 130-71, and 130-72 were reported. The last of these runs achieved continuous operation of the hydroclone. This made possible an increase in the coal feed rate. Detailed results are given. (EJH)

23924 (FE—2202-2, pp 13-31) **Task 1B: homogeneous catalysis; organometallic and transition metal compound catalysis.** Denson, D.D.; Lee, L.J.; Burkhouse, D.W. 18 May 1976.

In Homogeneous catalytic hydrocracking process for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 2, February 1, 1976—April 30, 1976.

A hydrogenation system has been designed and a screening design has been selected to determine the effects of six variables on the liquefaction of Synthoil: catalyst loading, temperature, pressure, solvent (Decalin and Tetralin), substrate concentration and stirring rate. Three catalyst systems were studied: chromium hexacarbonyl, $Cr(CO)_6$, cobalt octacarbonyl, $Co_2(CO)_8$, and titanium tetrachloride, $TiCl_4$. For all three catalysts, volatiles (which include gases from the catalyst and Synthoil in addition to distillate fuel from Synthoil) are maximized at high catalyst loading and low substrate concentration, i.e., at a catalyst/substrate ratio of 1:1. In $Cr(CO)_6$ and $Co_2(CO)_8$, the gas component of the volatiles increases with increasing temperature, whereas the fuel component decreases. In $TiCl_4$, temperature has a positive effect on both gas and fuel components. The positive effect of temperature on gas formation reflects catalyst hydride

formation or decomposition, or both, during the hydrogenolysis. For all three catalysts, the highest amount of distillate fuel is formed under the same conditions in the descending order: $Cr(CO)_6$ much greater than $TiCl_4$ < $Co_2(CO)_8$. On this basis, these reaction conditions have been selected initially as a model for further investigation: 10% catalyst, 10% substrate concentration, 700 psi hydrogen pressure, 100°C, and Tetralin as solvent.

23925 (FE—2202-2, pp 57-60) **Task 3A: thermodynamic and kinetic analysis of coal liquefaction chemistry.** Stein, S.E.; Shaw, R.; Golden, D.M.; Benson, S.W. 18 May 1976.

In Homogeneous catalytic hydrocracking process for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 2, February 1, 1976—April 30, 1976.

Heats of formation and entropies at 298°K and heat capacities at 300°K for the ideal gas state of some six-membered cyclic and polycyclic compounds related to coal were selected from the literature or estimated. Heats of formation were estimated by group additivity using group values previously published or were derived in this work. Entropies and heat capacities were estimated by group additivity or by using O'Neal and Benson's method. The most important factor in determining which isomer is most stable is the number of aromatic rings. The next most important factor is the conjugative interaction of a double bond with an aromatic ring. In coal, if it is assumed that structures are present in proportion to their thermochemical stability, the results determine the most likely structures in coal for given molecular formulas and numbers of six-membered rings. Heats of hydrogenation were calculated from heats of formation. Equilibrium constants for hydrogenation can be calculated as a function of temperature for comparison with those for hydrocracking, which is a competing reaction and desirable for the liquefaction of coal. An extension of group additivity techniques was used to predict standard gas-phase heats of formation, intrinsic entropies, and heat capacities for polycyclic aromatic hydrocarbons consisting of six-membered rings.

23926 (FE—2202-3, pp 13-22) **Task 1B: homogeneous catalysis; organometallic and transition metal coordination compound catalysis.** Lee, L.J.; Burkhouse, D.W. 15 Aug 1976.

In Homogeneous catalytic hydrocracking processes for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 3, May 1, 1976—July 31, 1976.

The hydrotreatment of Synthoil using selected carbonyl catalysts is complete. Analysis of the off-gases has shown very similar compositions, with CO the main component other than the starting hydrogen. Fuel yields were accurately calculated by subtracting out mass contributions from catalyst, solids, distillate residue, gases, and solvents, and correcting for the amount of fuel produced in the control run. This required further analyses to determine the catalyst distribution throughout the product mixture. In this way, the maximum fuel yield was determined to be 26% with $Mn_2(CO)_{10}$, which is the only catalyst tested that partly remains in the reaction solution. The others were observed to decompose [$Co_2(CO)_8$] or volatilize [$Cr(CO)_6$, $Mo(CO)_6$, and $W(CO)_6$] during the reaction.

23927 (FE—2202-3, pp 45) **Tast 3A: thermochemistry and kinetics of coal liquefaction.** Benson, S.W.; Stein, S.; Shaw, R.; Golden, D.M. 15 Aug 1976.

In Homogeneous catalytic hydrocracking processes for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 3, May 1, 1976—July 31, 1976.

It has been shown that relative values of π-bonding resonance stabilization energies for benzyl-type polycyclic aromatic radicals, as calculated by SCF-MO methods, closely correspond to energies calculated by the simple resonance theory approach of Herndon. The formula derived for the latter type of π-bonding resonance stabilization energy is E/sub πRSE//kcal mol^{-1} = 22.68 ln[CSC(R.)] - 27.33 ln[CSC(RH)] where CSC(R.) and CSC(RH) are the corrected structure counts (number of stable Kekule isomers) for the radical and parent molecule, respectively. Two methods are then suggested for modifying this formula to estimate empirical radical stabilization energies for use in predicting standard heats of formation of stabilized hydrocarbon radicals.

23928 (FE—2274-1) **Optimization studies of various coal-conversion systems. Quarterly report, April—July 1976.** Wen, C.Y. (West Virginia Univ., Morgantown (USA). Dept. of Chemical Engineering). Jul 1976. Contract E(49-18)-2274. 21p. Dep. NTIS $3.50.

Data from pilot units of coal conversion processes are being analyzed and modeled to provide for detailed design and optimization of coal liquefaction units. The effect of hydrogen partial pressure on coal dissolution rates was found to be proportional to P/ sub H2/$^{.05}$ in the 900-3000 psi range and the effect tends to diminish at very high pressure ranges. The absorption rate of hydrogen in a non-catalytic process increases to the first power of coal concentration. The gas absorption rate was influenced very little by the partial pressure of hydrogen.

23929 (ORNL/TM—5742) **Failure analysis of pressure letdown valve from the Synthoil Process Development Unit.** Edmonds, D.P.; Canonico, D.A.; Leslie, B.C. (Oak Ridge National Lab., Tenn. (USA)). Jan 1977. Contract W-7405-ENG-26. 18p. Dep. NTIS $4.00.

Several processes are being developed to convert coal with high S and ash contents to fuel oil with significantly lower concentrations of these constituents. One such process is Synthoil, a one-step hydrodesulfurization process that accomplishes over 94% conversion to oil in a short time. The reaction is carried out at temperatures around 450°C and pressures of 2000 and 4000 psig. One area subject to excessive wear is the pressure letdown valve on the product oil line. At 900 kg/day PDU at PERC, these valves, which operate at a pressure differential of 4000 psi and a temperature of 125°C must be replaced after about 1000 hr. One of these valves that failed in a typical manner after 915 hr was examined. It contained a replaceable trim set made of cemented WC inserts brazed to the valve plug and press-fitted to the valve seat. Failure of the valve was due to localized erosion of the WC inserts. The failure mode was preferential erosion-corrosion of the Co-Cr binder, allowing the hard WC particles to be washed away in the product oil. A full-scale Plexiglas model of the valve was made and it was found that slight misalignments of the plug with respect to the seat cause large changes in flow patterns through the valve. Many factors can change the local rate of erosion at a plug-to-seat region. In this case eccentricity of the trim set probably contributed to uneven flow aroundthe plug, and progressively higher local flow rates with increasing wear caused failure. The eccentricity may have arisen during manufacture or during service as a result of cracking of the stem-to-tip braze.

23930 **Coal: liquefaction.** *Mosaic;* **5**: No. 2, 30-31(Spr 1974).

Low-sulfur, low-ash liquid fuels for power plants have advantages over gases in that they can be manufactured and stockpiled and then distributed according to demand. Solvent-refined coal made by the SRC process can be used either as a liquid or solid. In the SRC process coal is mixed with a liquid solvent, itself derived from the coal, then heated and passed (with additional hydrogen) to a high pressure reactor. Hydrogen and hydrogen sulfide are then separated from the mixture, it is filtered, the solvent is distilled for reuse, and the final product is recovered either as liquid or solid. Some of the sulfur-containing compounds are removed as hydrogen sulfide. The remaining inorganic sulfur and other extraneous minerals are taken out during filtration. The result is a low-sulfur (0.5 percent), low-ash (0.1 percent) fuel for power plants. Research programs are discussed briefly: mathematical models of the process, fundamental chemistry, study of cost-controlling steps, foam flotation or filtration separation of ash and effects of coal types. (LTN)

23931 **Coal-liquefaction study to begin.** *Chem. Eng. (London);* **82**: No. 9, 51(28 Apr 1975).

The Electric Power Research Institute, Palo Alto, Calif., has agreed to sponsor a $1.1-million coal liquefaction research project with Amoco Oil Co., Chicago. The three-year project is designed to find an improved catalyst that will reduce the amount of hydrogen required.

PYROLYSIS AND CRACKING

23932 (FE—2202-2) **Homogeneous catalytic hydrocracking process for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 2, February 1, 1976—April 30, 1976.** (Stanford Research Inst., Menlo Park, Calif. (USA)). 18 May 1976. Contract E(49-18)-2202. 184p. Dep. NTIS $7.50.

The following tasks are discussed: Homogeneous Catalysis - Acid Catalysis; Homogeneous Catalysis - Organometallic and Transition Coordination Compound Catalysis; Coal Dissolution - Supercritical Media; Coal Dissolution - Reactive Solvents; Thermochemistry and Kinetics of Coal Liquefaction; and Coal Structure Studies. In addition there are four appendices. The reports on the various tasks were abstracted and indexed separately. (EJH)

23933 (FE—2202-2, pp 3-12) **Task 1A: homogeneous catalysis; acid catalysis.** Ross, D.S.; Low, J.Y. 18 May 1976.

In Homogeneous catalytic hydrocracking process for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 2, February 1, 1976—April 30, 1976.

Experiments in a Teflon-lined rocking autoclave have shown that $AlCl_3$/HCl catalyzes the degradation of coal to THF and pyridine-soluble materials at temperatures in the range 190 to 210°C. The work has shown that $AlCl_3$/HCl mixtures in the presence of H_2 are necessary for the process, and hydrocracking of the coal is likely. Experiments at 210°C and 5 hr resulted in a coal product with a pyridine solubility of about 60%, compared with a 17% solubility for the untreated coal. The system does not seem to work in a glass-lined or Teflon-lined monel stirred autoclave, an observation that currently cannot be explained. Hydride donors, such as tertiary hydrocarbons, decrease the conversions, possibly because a significant portion of the hydrogen charge is expended in the hydrocracking of the added hydrocarbon. The coal products from the hydrocracking experiments contain about 2% organic Cl.

23934 (FE—2202-3) **Homogeneous catalytic hydrocracking processes for conversion of coal to liquid fuels: basic and exploratory**

research. Quarterly report No. 3, May 1, 1976—July 31, 1976. (Stanford Research Inst., Menlo Park, Calif. (USA)). 15 Aug 1976. Contract E(49-18)-2202. 88p. Dep. NTIS $5.00.

The following tasks are discussed: Homogeneous Catalysis - Acid Catalysis; Homogeneous Catalysis - Organometallic and Transition Coordination Compound Catalysis; Coal Dissolution - Supercritical Media; Coal Dissolution - Reactive Solvents; Thermochemistry and Kinetics of Coal Liquefaction; and Coal Structure Studies. In addition there is one appendix. The various tasks were abstracted and indexed separately. (EJH)

23935 (FE—2202-3, pp 3-12) **Task 1A: homogeneous catalysis; acid catalysis.** Ross, D.S.; Low, J.Y. 15 Aug 1976.

In Homogeneous catalytic hydrocracking processes for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 3, May 1, 1976—July 31, 1976.

A catalyst screening study at two catalyst concentration levels with beneficiated coal was conducted. In the first series of tests, the catalyst/coal weight ratio of 1:1 was used. The results indicate the effectiveness of the catalyst in the following order (in each case, the corresponding hydrogen halide is present in the system): $AlCl_3$ < $AlBr_3$ much greater than $SbCl_5$ approximately equals SbF_3 approximately equals $ZnCl_2$ approximately equals TaF_5. When a constant molar quantity of catalyst is used, the order of effectiveness is significantly changed: $AlBr_3$ < $SbCl_5$ < $AlCl_3$ < TaF_5 much greater than SbF_5. A more detailed catalyst concentration level study was carried out with $AlCl_3$/HCl system. The conversion results suggest that the larger catalyst loading can affect the overall conversion significantly. With a catalyst/coal weight ratio of 3:1, the $AlCl_3$ catalyst system in a run at 210°C for 5 hr yielded a coal product essentially completely soluble in pyridine. However, the high loadings apparently bring about gasification, and the pyridine-soluble product from this run corresponded to only 55% of the starting coal. When unbeneficiated coal was treated with $AlCl_3$/HCl, a coal product with a THF solubility almost a factor of 2 greater than that for the beneficiated coal was obtained. The pyridine solubility was also larger.

SOLVENT EXTRACTION

REFER ALSO TO CITATION(S) 23943

23936 (FE—2202-2, pp 33-44) **Task 2A: solvent studies; supercritical media.** Ross, D.S.; Blessing, J.E. 18 May 1976.

In Homogeneous catalytic hydrocracking process for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 2, February 1, 1976—April 30, 1976.

Coal extraction experiments have been run with a number of supercritical media, including n-heptane, benzene, toluene, and similar hydrocarbons at 335°C and near-liquid densities. These supercritical fluids yielded coal products with THF and pyridine solubilities in some cases lower than those of the untreated coal. Solubilities of the coal products in the test media themselves at ambient temperature were greater than those of the untreated coal. Supercritical pyridine and t-butanol yielded products with similarly low solubilities. On the other hand, two propanols yielded coal products with significant increases in THF and pyridine solubilities. At densities of 0.14 g/ml, n-propanol, and i-propanol yielded products with pyridine solubilities of 21 and 39%, respectively. An i-propanol experiment at 0.50 g/ml yielded a coal product with a pyridine solubility of 50%. The results, when plotted against the Hildebrand solubility parameter values for the various media, fall into two regions: one region of lower solubilities where the media act only as solvents, and one region of relatively high solubility, where both solvent ability and chemical participation by the media are significant. The large difference in the results for t-butanol and the propanols suggests that H-donor activity takes place in the latter medium, and possibly involves hydride transfer from the oxygen-bearing carbon of the alcohol.

23937 (FE—2202-2, pp 45-56) **Task 2B: solvent studies; reactive solvents.** Hendry, D.G.; Hum, G. 18 May 1976.

In Homogeneous catalytic hydrocracking process for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No 2, February 1, 1976—April 30, 1976.

Investigation of the dissolution of beneficiated Illinois No. 6 coal with Tetralin and a phenol has not provided evidence that a free-radical chain process is involved in the dissolution. Phenanthrene and Tetralin show distinctly different behavior in coal dissolution. Phenanthrene by itself only partially dissolves the coal at 300 to 350°C, with little change in degree of solution after the first two hours. Tetralin, on the other hand, initially is slightly less effective than phenanthrene, but the dissolution continues with time. When Tetralin and phenanthrene are combined, the result is a more reactive system yielding higher percentages of dissolution than either solvent alone.

23938 (FE—2202-3, pp 23-35) **Task 2A: solvent studies; supercritical media.** Ross, D.S.; Blessing, J.E. 15 Aug 1976.

In Homogeneous catalytic hydrocracking processes for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 3, May 1, 1976—July 31, 1976.

Some additional solvents have been included in the supercritical media task. A plot of the pyridine solubilities of the coal products vs the Hildebrand solubility parameters for the media shows two dissolution regions. Most of the media fall in an area of relatively low solubility, suggesting that, in this region, the media are acting just as solvents. Secondary alcohols, on the other hand, fall in a region of higher solubilities, perhaps because some chemical action by the solvent, such as hydride donation, is increasing its dissolution capability. In autoclave experiments at 335°C for 90 min, i-propanol and Tetralin yielded coal products with similar pyridine solubilities, 50% and 47%, respectively. If small quantities of potassium isopropoxide are added to the i-propanol, then the coal product is essentially totally soluble in pyridine. The sulfur content is reduced from 2.2% to 0.4%. Finally, no major fraction of the coal is extracted by supercritical i-propanol, benzene, and methanol under these conditions.

23939 (FE—2202-3, pp 37-43) **Tast 2B: solvent studies; reactive solvents.** Hendry, D.G.; Hum, G.P. 15 Aug 1976.

In Homogeneous catalytic hydrocracking processes for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 3, May 1, 1976—July 31, 1976.

The chemical effect of a number of hydrocarbons on the dissolution of coal has been determined. The degree of dissolution of Illinois No. 6 coal (PSOC-26) was determined by using mixtures of 10% hydrocarbon and 90% phenanthrene. Pure phenanthrene gave 33 +- 3% dissolution in 2 to 20 hr. When 10% Tetralin was added to the solvent, the rate of dissolution increased, and after 2 hr, 60% dissolution was observed, and after 20 hr, 75%. Hydrocarbons do not contribute significantly to the chemical processes that lead to dissolution. The ability of a number of solvents to dissolve both beneficiated and unbeneficiated Illinois No. 6 coal (PSOC-26 and PSOC-25) has been studied. The beneficiation process clearly reduces the rate of dissolution of the coal in all the solvents. The effect is greatest at short reaction times. Phenanthrene dissolves about 38% of the unbeneficiated coal in 2 hr while dissolving about 33% of the beneficiated coal. Tetralin gives 50% dissolution of unbeneficiated coal in 2 hr, compared with 30% dissolution of beneficiated coal. After 20 hr, both samples give about 60% dissolution.

23940 **Direct metal reduction from coal.** Leas, L.E.; Leas, R.L.; Leas, A.M. (to Leas Brothers Development Corp.). US Patent 3,985,548. 12 Oct 1976. Filed date 30 May 1972. 6p.

A process is described for continuously and simultaneously extracting liquids from coal, gasifying the carbon to carbon monoxide, and utilizing the carbon monoxide for the direct reduction of iron ore. The process is carried out by continuously conveying a mixture of iron ore, coal, and oil in a moving solids bed through a single reactor tower, divided into a plurality of contiguous, communicating treatment zones.

PROPERTIES

REFER ALSO TO CITATION(S) 23892, 23934, 23956, 23957, 23958, 23959, 23960, 23961, 23963, 23966, 23973, 25149

23941 (BNL—21945) **Reactivity of coal chars with CO_2 at 1100-1600°C.** Yang, R.T.; Steinberg, M. (Brookhaven National Lab., Upton, N.Y. (USA)). Oct 1976. Contract EY-76-C-02-0016. 10p. (CONF-770301—3). Dep. NTIS $3.50.

From 173. national meeting of the American Chemical Society; New Orleans, Louisiana, United States of America (USA) (20 Mar 1977).

The chemical reactivity of chars from various ranks of coal with CO_2 has been studied using the diffusion cell technique which has been previously developed at BNL. Chars from the following coals were used: Montana lignite, Illinois No. 6 bituminous, and Pennsylvania anthracite. The reactivity peaks at a certain temperature and the peaking temperature can be correlated to the ash-melting temperature; this temperature varies widely from the range of 1100 to 1200°C to 1500 to 1600°C for the three coals. Results on the leached lignite and on the surface area measurements were also obtained and are used to discuss the effect of ash on the reactivity of char.

23942 (FE—2202-2, pp 61-83) **Task 3B: coal structure studies.** Mayo, F.R.; Kirshen, N.A. 18 May 1976.

In Homogeneous catalytic hydrocracking process for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 2, February 1, 1976—April 30, 1976.

this task includes oxidations of 2-naphthoic acid, a pyridine-soluble extract of Illinois No. 6 coal, and the extracted and insoluble remainder of such coal, all by aqueous sodium hypochlorite at 30 to 50°C. The experiments with naphthoic acid show that the oxidation

is pH-dependent, that the initial high rates of oxidation decrease much faster than the concentration of hypochlorite, and that both rings of naphthoic acid are attacked, with some accompanying chlorination. The oxidation of a porous, pyridine-extracted coal by sodium hypochlorite at pH 9.0 to 9.2 proved to be surprisingly fast at 30°C, most of the sample going into solution in three hours. Oxidation of a water dispersion of a pyridine extract of the same coal at pH 10.0 to 10.5 was much slower at 50°C, for reasons not yet clear, but nearly all the extract eventually dissolved in the alkaline solution.

23943 (FE—2202-3, pp 47-61) **Tast 3B: coal structure studies.** Mayo, F.R.; Kirshen, N.A. 15 Aug 1976.

In Homogeneous catalytic hydrocracking processes for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 3, May 1, 1976—July 31, 1976.

Further oxidations of fractions of Illinois No. 6 coal by aqueous sodium hypochlorite have been carried out, mostly on the insoluble residue of pyridine extraction, which represents 83% of the coal and the most important part of the liquefaction and structure problems. Recoveries of products have been improved and anomalies found in the effects of pH on rates and products of hypochlorite oxidations. Solvent-refined Illinois No. 6 coal has been separated into hexane-, toluene-, and pyridine-soluble fractions; these are compared with the corresponding fractions of the pyridine extraction of coal. The dehydrogenation of hydroaromatic to aromatic groups in coal appears to be important for structure studies by oxidation, and an experiment with an SRC fraction has begun.

23944 (LBL—5272) **Changes in the pore structure of coal with chemical processing.** Booras, G.S.; Petersen, E.E. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1976. Contract W-7405-ENG-48. 59p. Dep. NTIS $4.50.

Thesis.

Carbon dioxide adsorption experiments gave the same BET surface areas at room temperature and at dry ice temperature for a molecular sieve, an alumina catalyst, and a Wyoming subbituminous coal. This suggested that activated diffusion was not an important factor, even at 196°K. However, the adsorption of CO_2 on Illinois No. 6 coal decreased with increasing temperature. Surface area variations of desulfurized coal, extracted coal, and reacted coal were examined by carbon dioxide adsorption at 196°K. The use of NaOH to remove S from Illinois No. 6 coal appeared to cause partial blockage or collapsing of the pore structure. Subsequent extraction removed these obstructions somewhat. This conclusion was suggested by a minimum in the curve of surface area versus extraction time. Pyridine extractions of Roland Seam coal appeared to open new areas that were previously inaccessible to carbon dioxide. The surface areas were nearly doubled, but the average pore diameter appeared to remain essentially unchanged as evidenced by neopentane adsorptions. Large solvent molecules such as benzene were able to penetrate the coal pores, whereas a large, symmetrical molecule such as neopentane could not. These results suggest that the pores are slot shaped rather than cylindrical.

23945 (PERC—0063-3) **Hydrogen bonding in asphaltenes and coal. Progress report, July 1, 1976—December 31, 1976.** Li, N.C. (Duquesne Univ., Pittsburgh, Pa. (USA). Dept. of Chemistry). 4 Jan 1977. Contract EY-76-S-02-0063. 4p. Dep. NTIS $3.50.

Calorimetric studies of hydrogen bonding between quinoline and o-phenylphenol were carried out because they represent the nitrogenous heteronuclear aromatic bases and aromatic bases, respectively, found in the liquefaction products from coal. Further experiments are planned to try to resolve discrepancies observed between experimental and calculated values. (EJH)

23946 **Electron-binding energies for silicon minerals occurring in respirable coal dust.** Schultz, H.D.; Vesely, C.J.; Langer, D.W. *Appl. Spectrosc.;* **28**: No. 4, 374-375(1974).

Electron emission spectroscopy offers considerable promise as an analytical technique for chemical determinations. In this work, the electron-binding energy of several silicon compounds that potentially occur in respirable coal dust was measured. The preliminary data demonstrate the potential of electron spectroscopy to chemically characterize silicon and other potentially harmful constituents such as mercury, arsenic, cadmium, etc., directly on respirable mine dust and the parent coal samples.

23947 **Studies of ESR linewidths in coals and related materials.** Retcofsky, H.L.; Thompson, G.P.; Raymond, R.; Friedel, R.A. *Fuel;* **54**: 126-128(Apr 1975).

An investigation was carried out to explore the importance of two line-broadening mechanisms that may be responsible for the width of the electron spin resonance (e.s.r.) signals exhibited by coals. Studies of catalytically dehydrogenated coals, isotopically substituted low-temperature chars, and a large number of vitrains from coals of all ranks support the view that electron-nuclear hyperfine interactions produce significant contributions to the e.s.r. linewidths found for low-rank coals. Anisotropic g-values appear to be relatively unimportant for low-rank coals, but measurements made on oriented sections of young anthracitic coals revealed a small but reproducible anisotropy in the e.s.r. g tensor.

23948 (ERDA-tr—183) **Thermophysical and electrophysical properties of combustion products with seed.** Nedospasov, A.V.; Poberezhskii, L.P.; Chernov, Yu.G.; Gaponov, I.M. (AN SSSR, Moscow. Inst. Vysokikh Temperatur). Sep 1976. Translation of USSR report. 68p. Dep. NTIS $4.50.

Theoretical and experimental studies dealing with the electric conductivity of combustion products of gaseous fuels with a readily ionizable alkali metal seed have been published rather widely. A comparison of experimental and theoretical data made in these studies showed good agreement, and it may therefore be assumed that the calculations of the properties of combustion products of gaseous fuels can be made in a reliable manner. The present report presents the results of calculations of the properties of combustion products of bituminuous coal and fuel oil with a readily ionizable seed. In view of the lack of experimental data on the electric conductivity, sigma, of the plasma of combustion products of bituminous coal and fuel oil over a wide range of the initial parameters determining sigma of plasma, they cannot be compared with the calculated data. For this reason, the results of calculations presented here should be considered tentative.

23949 **Determination of field-ionization relative sensitivities for the analysis of coal-derived liquids and their correlation with low-voltage electron-impact relative sensitivities.** Scheppele, S.E.; Grizzle, P.L.; Greenwood, G.J.; Marriott, T.D.; Perreira, N.B. (Oklahoma State Univ., Stillwater). *Anal. Chem.;* 48: No. 14, 2105-2113(Dec 1976).

Field-ionization (FI) and flame-ionization detector sensitivities have been determined for 60 aromatic compounds relative to ethylbenzene. The compounds studied are in general typical of those encountered in coal-derived liquids. The sensitivities are within the limits of experimental precision independent of sample composition. For predictive purposes, the FI relative cross sections and relative sensitivities are correlated with low-voltage electron-impact (EI) relative cross sections and relative sensitivities, respectively, and with -Z. The variations in the FI relative cross sections with change in molecular structure are not as large as those for ionization by low-voltage electrons; however, the trends are similar. For three synthetic blends, quantitative distributions calculated from FI ion abundances assuming unit relative sensitivities are in significantly better agreement with the known distributions than those similarly calculated from the low-voltage EI data. Inclusion of sensitivities into both analyses produces excellent agreement with the known distributions.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 23957, 23958, 23959, 23960, 23961, 23975, 25128

23950 (CONF-761131—1) **Chemical characterization and monitoring studies of effluents from emerging fossil fuel processes.** Clark, B.R. (Oak Ridge National Lab., Tenn. (USA)). 1976. Contract W-7405-ENG-26;EPA-IAG-D5-E681. 9p. Dep. NTIS $3.50.

From Air Pollution Control Association specialty conference; Cambridge, Massachusetts, United States of America (USA) (8 Nov 1976).

Approaches to the chemical characterization of aqueous wastes and gas phase fugitive emissions are reported. Characterization studies are directed toward known hazardous materials or toward chemical class fractions and components deemed likely hazards from bioactivity data obtained in the development of screening methodologies. Analytical techniques include multicomponent gas chromatographic profiling with element selective detectors, blind assays using biological activity data, chemical class fractionation for specific compound type characterization and use in bioassay studies, and many conventional methods of chemical identification. Specific studies have included: (1) characterization of occupational exposure to polynuclear aromatic hydrocarbons (PAH) in fugitive emissions; (2) determination of correlations between PAH content and bioactivity for several materials; (3) analyses of volatile components in headspace gases; (4) analyses of real and synthetic stack gas mixtures; (5) characterization of aqueous by-products from oil shale retorting, coal liquefaction, and petroleum refining; and (6) development of bioassay inhalation devices.

23951 (LA-UR—76-2198) **Disposal of coal preparation wastes: environmental considerations.** Wewerka, E.M.; Williams, J.M.; Vanderborgh, N.E. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 8p. (CONF-761016—2). Dep. NTIS $3.50.

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976).

The mineral wastes from coal preparation and mine development constitute a major environmental problem. Over 3-billion tons of these materials have accumulated in the U.S., and the current annual rate of waste production of 100 million tons/yr is expected to double within a decade. The total number of active and abandoned coal waste dumps is estimated to be between 3000 and 5000. About one-half of these pose some type of health, environmental, or safety problem. Structural weaknesses in coal refuse banks have led to tragic landslides such as those at Buffalo Creek, WV and Aberfan, Wales. Coal refuse dumps are also one of the sources of highly mineralized, acidic drainage, which affects more than 10-thousand miles of streams and waterways, and the 300 or so burning waste banks are a major source of air pollution. In addition to these problems, there is growing concern about possible environmental effects from the trace elements in the coal waste materials. The various forms of environmental pollution from coal mineral wastes, the extent and seriousness of each, and some of the control methods which are being used to alleviate or lessen the environmental impact are described.

23952 (ORNL-tr—4216) **Fly ash from boiler houses as absorbent for phenol in waste water.** Riedl, R.; Macak, J.; Benes, M. Translated by S.D. Blalock Jr. from *Paliva;* **35**: 260-263(1955). 11p. Dep. NTIS $3.50.

It is evident from the results of the tests that it is possible to use ash from boilers successfully for final purification for both carbonization water after phenol has been removed with benzol and treated in an ammonia plant, and also for water from pressure gasification after extraction with phenosolvate. The quantity of ash necessary to purify 1 m^3 of water will be dependent on the degree of pre-purification of the water and on the adsorptive capacity of the wash, as well as on the desired degree of purification. These capacities are very different, depending on the kind of coal, ratio in the furnace, clinker content, etc. They can be essentially increased by hydrochloric acid activation. It is possible to say, and for a rough approximation, that to thoroughly purify carbonization water after extraction with benzol and boiling-off in an ammonia plant, about 10 to 15 percent by weight of satisfactorily active ash would be necessary, while to thoroughly purify water from a pressure gasworks containing bivalent phenols, after its modification with phenosolvate, about 20 to 30 percent by weight of satisfactorily active ash would be necessary. The arrangement would probably be similar to the arrangement in the Boehlen plant. The active capacity of the ash, however, is very diverse, just as the active capacity of the waste from the Winkler generators is (the activity of the Winkler dust in Boehlen is essentially greater than from STAZA [expansion unknown]). A very good approximation can also be made by simple adsorption of pure phenol. In every case for projection purposes it is really necessary to proceed with particular care.

23953 **Coal waste bank parameters given in new USBM report.** Busch, R.A.; Backer, R.R.; Atkins, L.A. *Coal Min. Process.;* **12**: No. 7, 52-53(Jul 1975).

The study summarized in Bureau of Mines Report of Investigations 7964 was a direct result of the Buffalo Creek disaster of February 1972, which took the lives of 125 West Virginians. A task force was created to analyze the West Virginia embankment failure and to identify other potentially hazardous sites. The long-term objectives were to develop means to determine modes of embankment failure and to develop methods for safe disposal of the coal waste materials.

23954 **Modern techniques to remove H_2S and NH_3 from coal gas.** Hahn, E.; Herpers, E.T.; Neff, I. (Otto (C.) und Co. G.m.b.H., Bochum (Germany, F.R.)). *Chem. Ind. (Duesseldorf):* **28**: No. 8, 461-465(Aug 1976). (In German).

4 figs.

Neutralization and oxidation methods to remove H_2S and NH_3 from coal gas are described. The process steps of the Otto Sulfammon process (neutralization method), the Sidmar Otto method (oxidation of H_2S to elementary sulfur) and of the Retu Ammon method are individually explained. The latter is of particular use when one needs to selectively wash ammonia out of gases. Finally, the USS Phosam method is briefly mentioned which is especially for the removal of ammonia from natural gas, coke oven gas as well as firm waste gases of petroleum chemistry.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 23906, 23909, 23915, 23951, 23953, 24885, 25277, 25298, 25308

23955 (LA—6564-MS) **Potential production of photochemical oxidants from coal gasification facilities.** Williams, M.D. (Los Alamos Scientific Lab., N.Mex. (USA)). Dec 1976. Contract W-7405-ENG-36. 16p. Dep. NTIS $3.50.

Coal gasification facilities are potential sources of both reactive hydrocarbons and nitrogen oxides. It is thus conceivable that photochemical reactions may produce ozone in the plumes of these facilities. This possibility was examined by a three-step process. First, the dispersion of hydrocarbons and nitrogen oxides from a proposed facility was modeled. Next, the modeled concentrations were compared to concentrations in urban areas that have been associated with ozone production. Finally, a set of chemical equations has been solved and estimates of ozone production have been obtained. The results suggest that ozone production may be expected in gasification plumes.

23956 (LA-UR—76-2197) **Contaminants in coals and coal residues.** Wewerka, E.M.; Williams, J.M.; Vanderborgh, N.E. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 24p. (CONF-761016—1). Dep. NTIS $3.50.

From 4. national conference on energy and the environment; Cincinnati, Ohio, United States of America (USA) (5 Oct 1976).

Most of the major enviromental pollutants from coals originate as impurities in the coal structure. These include various organic compounds, minerals, and trace elements that are released into the air and water when coal is mined, processed and utilized. The use of coal preparation to produce cleaner burning fuels involves an environmental compromise, wherein reduced emissions and solid wastes from coal burning sources are achieved at the expense of greater environmental degradation from coal cleaning wastes.

23957 (NP—21352/1) **Coal fired power plant trace element study. Volume I. A three station comparison.** (Radian Corp., Austin, Tex. (USA)). Sep 1975. 82p. Radian Corp., Austin, TX.

This report summarizes the results of a program to characterize the trace element emissions from three coal-fired electric generating stations. A material balance approach was used for a quantitative examination of 27 elements. An additional 26 elements were surveyed semiquantitatively. The trace elements can be broadly classed into three general groups; (1) those uniformly distributed in the coal ash, (2) those preferentially emitted with the fly ash, and (3) those emitted as vapors in the flue gas. The selection of stations using different coals with different boiler and particulate collection configurations provided a comparison of trace element emissions as a function of plant design and operating parameters. The overall report is presented in four volumes. Volume I compares the three stations. Volumes II, III and IV give detailed results and descriptions of the methodology used for the individual stations.

23958 (NP—21352/2-4) **Coal fired power plant trace element study. A three station comparison.** (Radian Corp., Austin, Tex. (USA)). Sep 1975. vp. Radian Corp., Austin, TX.

The three volumes contained in this binding were abstracted and indexed separately. (DJH)

23959 (NP—21352/2-4, pp vp, Paper 1) **Coal fired power plant trace element study. Volume II. Station I.** Sep 1975.

In Coal fired power plant trace element study. A three station comparison.

Station I is an example of a subbituminous coal-fired boiler using venturi wet scrubbers for particulate control. The sampling and characterization of trace elements in Station I streams resulted in closure of material balances for some 24 of the 27 elements examined in detail. Additional information of a semi-quantitative nature was obtained for a total of 53 elements using spark source mass spectrometry. The distribution of the trace elements among the station exit streams as a function of coal composition and station operating configuration is essential information for the eventual development of predictive techniques. For Station I the following elements were found to be concentrated in the flue gas stream and depleted in the bottom ash stream: S, Hg, Cl, Sb, F, Se, Pb, Mo, Ni, B, Zn, Cd, Cr, Cu, Co, As, Ag, and V. The following elements are distributed in proportion to the total ash flows with no concentration or depletion evident: Ba, Be, Al, Ca, Fe, Mg, Mn, and Ti. The results for U were somewhat anomalous as it was concentrated in the bottom ash and depleted in the precipitator ash. A detailed comparison of this station with generating stations using hot-side electrostatic precipitators and mechanical particulate collection is given in Volume I of this series.

23960 (NP—21352/2-4, pp vp, Paper 2) **Coal fired power plant trace element study. Volume III. Station II.** Sep 1975.

In Coal fired power plant trace element study. A three station comparison.

Station II is representative of a generating station firing subbituminous coal and using a hot-side electrostatic precipitator for particulate control. All station streams were sampled and analyzed to determine the trace element content. Material balance closure was achieved for some 23 of the 27 elements characterized in detail. In addition, semi-quantitative results were obtained by spark source mass spectrometry for a total of 53 elements. Development of correlations permitting the prediction of emissions from coal-fired generating stations will require an extensive data base relating the distribution of trace elements as a function of coal composition and operating conditions. For Station II, the following elements were found to be concentrated in the flue gas emissions over the amount

expected from the mass of the ash: S, Hg, Cl, Sb, Cr, F, Se, Pb, Mo, Ni, B, Zn, and Cd. The following elements appear to be uniformly distributed in the ash streams: Ba, Be, V, Al, Ca, Fe, Mg, Mn, and Ti. The elements Cu, Co, U, Sb, and Ag display intermediate behavior and are enriched in the precipitator ash stream. These results are compared and contrasted in Volume I with Stations I and III using wet scrubbing and mechanical particulate collection, respectively.

23961 (NP—21352/2-4, pp vp, Paper 3) **Coal fired power plant trace element study. Volume IV. Station III.** Sep 1975.

In Coal fired power plant trace element study. A three station comparison.

The detailed sampling and characterization of trace elements in Station III streams resulted in excellent material balance closure for some 21 of the 27 elements examined in detail. A total of 53 elements were tested on a semiquantitative basis using spark source mass spectrometry. A long-range objective is the correlation of the trace element content of each outlet stream with the coal input. A wide variation was found between elements as to their relative distribution in plant streams. The following elements were found to be concentrated in the flue gas stream: S, Hg, Cl, Sb, F, Se, Pb, Mo, Ni, B, Zn, Cd, Cr, Cu, and Co. In contrast, the following elements are more or less distributed in direct proportion to the total ash content of each stream: Ba, Be, V, Al, Ca, Fe, Mn, Mg, and Ti. The elements U, Sb, and Ag display intermediate behavior. These characteristics of a lignite-fired cyclone boiler with mechanical ash collection are compared with other plant configurations and coal compositions in Volume I of this report series.

RESERVES AND EXPLORATION

REFER ALSO TO CITATION(S) 23916

23962 (NP—21265) **Capps Glacier-Beluga coal economic resource analysis.** Dobey, P.L.; Welch, J.; O'Connor, K.M. (Alaska State Dept. of Natural Resources, Anchorage (USA). Div. of Geological and Geophysical Survey). 28 Nov 1975. 20p. Alaska State Dept. of Natural Resources, Anchorage.

An economic analysis of the direct monetary value to the state for coal resources in the Capps Glacier-Beluga State land trade area has been completed for the Division of Lands. This analysis uses a development model to show the possible royalty revenues the state would expect from the coal in the zone considered for trade. Conservative parameters were used and the economic analysis completed only on the measured and indicated coal reserves of the Capps Glacier area. It is very probable that the Beluga coal reserves to the southeast will be developed before any of the coal in the trade zone. This could create a much longer time to development than the model, resulting in an even lower net present value of the measured and indicated coals of the trade zone. Hypothetical coal resources could add another 500 million tons of potential reserves to the area, but their development lies so far in the future an economic analysis of their royalty value is meaningless. Because of the probable extremely low royalty revenues resulting under the present state contract and the long time delay for income under more favorable royalties, the present dollar value of the trade zone (with respect to royalty income) is very low per acre. The total present value of the theoretical royalty income discounted 10% would range from $12.22/acre in the pessimistic case, $32.79 in the medium case, and $80.05 in the optimistic case.

23963 (USGS-OFR—76-319) **Preliminary report of coal drillhole data and chemical analyses of coal beds in Campbell and Sheridan counties, Wyoming; Custer, Prairie, and Garfield counties, Montana; and Mercer County, North Dakota.** (Geological Survey, Washington, D.C. (USA); Geological Survey, Helena, Mont. (USA)). 1976. 379p. TIC.

Except for six pages, this report consists of maps showing the location of holes drilled, coal bed data, and coal analysis reports. (EJH)

23964 Method for the localization and qualitative determination of underground coal and oil shale formations by means of inelastic neutron scattering. McKinlay, P.F.; Smith, H.D. Jr.; Schultz, W.E. (to Texaco Development Corp.). German(FRG) Patent 2,427,127/A/. 2 Jan 1975. 35p. (In German).

5 figs.

A borehole probe with a pulsed neutron source for 14 MeV neutrons (D-T) is concucted through a liquid-filled borehole. Inelastic γ-measurements of neutrons are observed in at least four different energy ranges of the γ-spectrum corresponding with the inelastic γ-scattering picture of carbon, oxygen, silicon, and calcium. The carbon/oxygen ratio and the calcium/silicon ratio of this inelastic γ-radiation and the sum of the inelastic γ-radiation of carbon and oxygen are determined. Each of the amounts described earlier can be recorded as a funktion of the depth of the borehole. Separately determined logs of common natural γ-radiation and γ-density may then be applied together with the three inelastic γ-logs for the purpose of distinguishing coal and oil shale formations and of deriving a quantitative indication of the calorific power of the coal formation and the amount of oil to be produced from the oil shale formation.

23965 Washability equations for Jharia raw coal from seams VIII-XVIII. Winiewski, J. (Bharat Coking Coal Ltd, Dhanbad, India). *J. Mines, Met. Fuels;* **24**: No. 1, 3-10(Jan 1976).

Detailed investigations into the properties of India's Jharia coal have revealed the existence of some regularities in the Jharia coalfield. This especially applies to the washability of raw coal from certain seams. The coal's washability is found to improve from lower to upper seams and, also, simultaneously, from west to east of the coalfield. This indicates that there exists some interrelation between the washability of raw coal on one hand and the stratigraphy of the coalfield on the other. Further, equations are given to prove that the washability of raw coal also depends on the sedimentation conditions which existed during the formation of the coalfield. 7 refs.

23966 Mineral matter in coals of Ramagundam-Bellampili coal belt, Andhra Pradesh. Moiz, A.A.; Ramana Rao, N. (Osmania Univ, Hyderabad, India). *J. Mines, Met. Fuels;* **24**: No. 2, 63-65, 58(Feb 1976).

The coals from India's Ramagundam-Bellampalli coal belt reveal a high percentage of mineral matter in petrographic and chemical analyses. Minerals such as quartz, pyrite, marcasite and calcite were observed in close association with various microlithotypes. The occurrence of alternating bands of clay and shale with the micro-laminated layers of organic constituents is an inherent characteristic of these coals. Consequently, the conventional methods of coal cleaning may not considerably reduce the proportion of mineral matter. 6 refs.

MINING

REFER ALSO TO CITATION(S) 23951

23967 Coal beds: a source of natural gas. Deul, M.; Kim, A.G. *Oil Gas J.;* **73**: No. 24, 47-49(16 Jun 1975).

Work by the Bureau of Mines has demonstrated that coalbeds can yield substantial quantities of pipeline quality natural gas. The estimated volume of gas contained in U.S. coals—some 800 trillion cubic feet—is equivalent to the proved and currently recoverable reserves of natural gas in the United States. The necessary technology to drain and recover much of this gas is already available.

23968 Speeding coal mining operations by recovering and utilizing methane from coal beds. Deul, M.; Skow, W. *Coal Age;* **80**: No. 8, 104-106(Jul 1975).

Bureau of Mines research has shown that most of the methane can be removed from permeable coalbeds before the coal is mined, and that by using hydraulic stimulation—a well-established oilfield technique—commercial quantities of pipeline-quality gas can be produced. To help transfer these research results into commercial practice that will begin to recover the vast resource of coalbed gas, a program has been undertaken to demonstrate the commercial feasibility of recovering and utilizing methane from coalbeds and underground gob areas.

23969 New concepts and techniques spark the Bureau's advanced mining systems program. Strebig, K.; Reese, H.B. *Coal Age;* **80**: No. 8, 125-127(Jul 1975).

The goal of the Bureau of Mines advanced mining systems research program is to develop new, innovative mining systems that will enable the mining of deposits presently unminable due to either economic or technological factors. The program plans to achieve this goal by delineating the key mine problems, developing alternatives for solutions, and selecting the best approaches based on economic, health, and safety factors.

23970 How industry can work as a team with the Bureau to boost coal mining productivity. Jancik, J.J. *Coal Age;* **80**: No. 8, 99-103(Jul 1975).

The Bureau of Mines has been given the lead role in planning and implementing a long-range coal extraction program that could cost the Federal Government as much as $450 million in the next 5 years. The near-term goal of this program is to develop technologies that will result in significant increases in production, efficiency, and resource recovery with present surface and underground mining methods. The long-term goal is to develop efficient mining methods for the more difficult or deeper coal seams. Implementation of the extraction research and development program will be done largely through contracts.

23971 Recover coalbed gas. Deul, M. *Hydrocarbon Process.;* 86-87(Jul 1975).

Gas contained in coalbeds is an attractive source of energy. Technology for its recovery is available and sources where it can be found are known. The demand for new energy sources, coupled with higher energy prices, makes the recovery of coalbed gas a matter of energy management. The scientific and technical basis for coalbed degasification as a source of pipeline-quality gas has already been established. All that now remains is refinement of techniques of gas production from coalbeds and further evaluation of gas content of lower rank deep subbituminous coalbeds of the Western States and of the anthracite region of eastern Pennsylvania.

23972 Ventilation in Indian coal mines: some observations. Singh, H.C.; Kaiser, K.M. (Cent Min Res Stn, Dhanbad, India). *J. Mines, Met. Fuels;* **24**: No. 2, 53-58(Feb 1976).

The Central Mining Research Station, of Dhanbad, has carried out ventilation studies in 67 mines in India. These included the surveys of pressure, quantity and temperature in mines, and a study of the performance of surface and underground fans. Information gathered during these investigations has been used for modifying ventilation systems of existing mines and for planning ventilation systems of new mines. Some salient features of the ventilation conditions observed during these surveys are discussed here.

23973 Method of working at Monidih project. Varma, K.M.P.; Bhattacharjee, T. *J. Mines, Met. Fuels;* **24**: No. 3, 75-89(Mar 1976).

In the Monidih leasehold, the coal-bearing Barakar Formation contains over 15 seams with thickness in excess of 1.2 m., but only six of these are to be mined, thanks to the prime coking properties of their coal. Data pertaining to coal-seam quality and thickness are given along with the details of this coal-mining project, and the planned methods of working the coal-seams are discussed in detail. Other subjects discussed include the mechanization of longwall faces, methods of supporting, ventilation, transport and manpower. Some problems associated with the presence of faults and poor roof conditions at the longwall face are also discussed.

23974 Kaiser resources. *Coal Miner;* **1**: No. 2, C8-C10, C12, C14(Jun 1976).

The largest coal mine in Canada is Kaiser Resource's operation at Sparwood in the southeastern corner of BC. Kaiser currently operates North America's only hydraulic coal mine and is engaged in marketing its hydraulic mining technology to other companies in conjunction with V/O Licensintorg of the Soviet Union and Mitsui Mining Co of Japan. The major portion of Kaiser's production, though, is derived from surface operations. Altogether about 85% of the approximately 6-million tons of clean metallurgical coal produced each year comes from above ground mining. The remainder is mined underground, primarily by the hydraulic method. A total of 5.6-million tons of clean metallurgical coal were processed at the Elkview preparation plant last year (1975). The remainder after the Japanese commitment is shipped, along with thermal coals, coke and by-products to customers in Canada, the United States, Europe, Korea and Mexico.

23975 Strip coal mining in the Bowen Basin. Utah's four big mines. *Aust. Min.;* **68**: No. 6, 16-19(Jun 1976).

The Bowen Basin, in Central Queensland, is one of the world's major sources of coking coal. The basin, which stretches from Theodore in the south 480 km to Collinsville in the north, and inland from the coast 225 km to Blair Athol, is known to contain reserves of more than 10,000 million tonnes. The main coal resources are permian coking coals but major tonnages of young steam coals occur. Along the western flank of the basin, Utah Development Company is working four open cut mines, producing coking coal mainly for export to Japan.

23976 Device for sucking off stone dusts. Kuehnapfel, F.; Koppers, M.; Goeretz, H. (to Rheinstahl A.G.; Bergwerksverband G.m.b.H., Essen (Germany, F.R.)). German(FRG) Patent 2,502,062/A/. 22 Jul 1976. 7p. (In German).

2 figs. Available from Dt. Patentamt, Muenchen (FRG).

For sucking up in particular the dust- which is harmful to the lungs - when constructing moving face supports in coal mining, a device has been outlined. This piece of apparatus seals the gap between two assembly supports in the area of the caps or the stress plates by means of resilient anchor guard plates, thus making the gap dust-proof. A suction pipe with an injector is planned for sucking up the dust.

23977 Process preventing dust formation in coal mining with shield supports. Lewer, H. (to Chemische Fabrik Kalk G.m.b.H.). German(FRG) Patent 2,509,042/A/. 2 Sep 1976. 6p. (In German).

Available from Dt. Patentamt, Muenchen (FRG).

This is a method to prevent the formation of dusts in coal mining by means of hygroscopic salt pastes. After coal winning and directly before the shield supports are installed, a layer of dust-binding paste 1-10 mm thick is applied to the freed surfaces. The paste may be made of calcium and/or magnesium chloride.

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 23912, 23951, 23956, 23966, 23973, 23974

23978 Continuous face-to-preparation-plant coal haulage systems. Kleysteuber, W.K.; Nasiatka, T.M. *Coal Age;* **80**: No. 8, 117-122(Jul 1975).

The production capabilities of presently available coal extraction machinery far exceed the capabilities of existing haulage systems to move the product from the face to the preparation plant. All elements of the transportation problem are considered under the Bureau of Mines research and developmet program; that is, attention is paid not only to conveying the coal and waste rock but also to transporting personnel, supplies, and equipment between the coal face and the surface and within the mine.

23979 Coal drying and passivation process. Johnson, C.A.; Volk, W. (to Hydrocarbon Research, Inc.). US Patent 3,985,516. 12 Oct 1976. Filed date 20 Aug 1975. 6p.

Low rank coals such as subbituminous or lignites containing more than about 10 wt. percent moisture are first dried and then passed to a fluidized bed where the coal is passivated against reabsorption of moisture by coating the warm coal particles with a heavy liquid hydrocarbon material. Such coating substantially prevents the reabsorption of moisture in the coal, and thereby prevents autogenous heating and possible spontaneous ignition during subsequent transportation or storage of the passivated coal.

23980 Coal passivation process. Johnson, C.A. (to Hydrocarbon Research, Inc.). US Patent 3,985,517. 12 Oct 1976. Filed date 20 Aug 1975. 6p.

Low rank coals such as subbituminous or lignites containing more than about 10 percent moisture are dried and passivated against reabsorption of moisture in a fluidized bed by heating the particulate coal with a warm inert gas passing upwardly through the bed and simultaneously coating the warm particulate coal with a heavy liquid hydrocarbon material. Such coating aids in the removal of the moisture and prevents the reabsorption of moisture by the coal and thereby prevents consequential heating and possibly spontaneous ignition of the coal during its subsequent transportation or storage.

COMBUSTION

REFER ALSO TO CITATION(S) 23900, 23948, 24951

23981 (CONF-761047—4) Facility to study the effect of tubulent mixing in pulverized coal combustion. Thurgood, J.R.; Smoot, L.D.; Rees, D. (Brigham Young Univ., Provo, Utah (USA)). 1976. 20p. Brigham Young Univ., Provo, UT.

From The Combustion Institute meeting; LaJolla, California, United States of America (USA) (18 Oct 1976).

An atmospheric combustion facility was designed and constructed to study the effects of turbulent mixing and the kinetic processes occurring in pulverized coal combustors. The experimental test program includes 52 reacting coal/air tests and 24 reacting char/air tests. Test variables include percent coal loading in the primary stream, percent excess air, coal volatility, and particle size, primary/secondary stream velocity ratio, primary and secondary stream injection temperatures, and the injection angle of the secondary stream to the primary stream. The reactor was constructed in sections, one of which is a probe section. The probes allow for simultaneous gas/particulate sampling and can be positioned in the reactor to sample both radially and axially. Use of gas and particle tracers coupled with probe sample analysis will enable the determination of: (1) the local extent of mixing of primary and secondary gases, (2) the local extent of particle dispersion, (3) the local extent of particle reaction, and (4) the local extent of pollutant formation. Checkout tests on the facility were completed and methane/air and coal/air flames have been stabilized. Trial tests with both water cooled and direct water quench probes are under way.

23982 (FE—2018-4) Fundamentals of nitric oxide formation in fossil fuel combustion. Quarterly progress report, March 11—June 10, 1976. Houser, T. (Western Michigan Univ., Kalamazoo (USA). Dept. of Chemistry). Jul 1976. Contract E(49-18)-2018. 24p. Dep. NTIS $3.50.

A study of the reaction mechanism which leads to NO formation from fuel nitrogen by determining the rate and mechanism of pyridine pyrolysis was continued. In addition to the previously reported volatile products, hydrogen was found in the reactor exit stream. It was found that as the reactor's surface to volume increased, the pyrolysis rate decreased indicating radical recombinations play an important role in the rate of the reaction. The addition of cyanogen to the carrier gas increased the rate significantly. Both the surface and cyanogen effects indicate a chain mechanism may be

operating. The mechanistic implications of the data from this program and from related investigations are reviewed.

23983 (FE—2473-3) **Industrial application of fluidized-bed combustion: phase I. Quarterly report, July 1—September 30, 1976.** Norcross, W.R. (Combustion Engineering, Inc., Windsor, Conn. (USA)). 28 Oct 1976. Contract E(49-18)-2473-PHA-1. 16p. Dep. NTIS $3.50.

Work was initiated on development activities. A cold flow model test program was completed and issued to ERDA for approval. Instrumentation required to acquire data was requested to be transferred from the ERDA-sponsored low-Btu gasification of coal project (PDU) to the Fluidized-Bed Project. A preliminary system mass and energy balance for the sub-scale unit was evaluated. A theoretical analysis of bed expansion during operation was made to study bed performance at various operating load conditions. Initial design of the sub-scale unit pressure parts, bed grid plate, and air plenum is being investigated. Associated equipment such as the cyclone, bag filter, and fans are all sized. Specifications for this equipment were written so that quotations and approvals can be obtained. An analysis of the required instrumentation and control system and a technique of data acquisition during the testing of the sub-scale unit was initiated. Identification of the selection of data to be recorded during the testing of the sub-scale unit is being reviewed. The schedule for the entire program is provided. The test program for the cold flow model activity is a comprehensive endeavor that addresses itself to the significant design considerations critical to the inlet plenum and bed plate distributor final configuration. The actual testing of the cold flow models will occur during the next two quarters.Sub-scale unit preliminary design activity to date has essentially completed the identification of the unit criteria for design. The unit has been selected based on conservative proportioning of heating surface and will meet state and federal regulations. Preliminary investigations into the conditions at the demonstration plant site indicate that adequate space is available to locate all boiler equipment.

23984 (FE—2489-4) **Development of combustion data to utilize low-Btu gases as industrial process fuels. Project 8985 quarterly status report No. 1, October 1—December 31, 1976.** Shoffstall, D.R. (Institute of Gas Technology, Chicago, Ill. (USA)). Jan 1977. Contract E(49-18)-2489-PRJ-8985. 6p. Dep. NTIS $3.50.

The following modifications to the pilot-scale test furnace were completed during the quarter: (1) cutting slots in the furnace roof to permit insertion of the bayonet cooling tubes and (2) the construction and installation on the furnace roof of a carriage for the cooling-water inlet manifolds and water-return troughs. Also, construction was initiated on the bayonet cooling tubes and the char-doping system. Because of problems that developed at the Institute of Gas Technology (IGT) during operation of the existing reformer, which is owned by the Electric Power Research Institute (EPRI), Surface Combustion was requested to make several design modifications to the proposed gas-generating system to meet program performance requirements. Construction drawings that included these modifications were approved by the Energy Research and Development Administration (ERDA) program manager, and fabrication of the gas-generating system was begun by Surface Combustion in November. A foundation was installed for the reformer at the IGT Combustion Research facility in preparation for receiving this gas-generating system.

23985 Sulfur dioxide reduction by combustion of coals in fluidized beds of limestone. Coates, N.H.; Rice, R.L. *AIChE Symp. Ser.;* **71**: No. 141, 124-129(1974).

Mines tested various coals as fuel in fluidized beds of limestone, compared sulfur retention, and measured heat transfer with tubes immersed in the bed. The program involved testing five types of bituminous coal from high volatile A to low volatile, which ranged in ash content from 8 to 24 percent and in sulfur content from 2 to 4 percent.

23986 Calculation of the burnout of polydispersed anthracite fine p.f. given joint reaction with natural gas. Lebedev, F.M. (Ukr SSR Corresp Polytech Inst). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 5, 51-58(May 1976). (In Russian).

Using the Runge-Kutta method, a system of differential and algebraic equations for 10 fractions of grain characteristics of anthracite fines p.f. and natural gas is solved given the condition of parallel reactions of the fractions and the gas. A regularity of the burnout of a fraction over the length of the torch of the p.f. alone and in a mixture with natural gas, given different proportion of the gas as regards heat emission, is established for four conditions calculated. This calculation was preceded by a great deal of work on establishing initial and boundary conditions on an industrial furnace which has permitted the calculations to be brought closer to real conditions. The conditions of combustion of fractions and the cause of the appearance of mechanical underfiring are revealed. This permits more correct choice of the scheme of burning low-reactivity fuels with natural gas.

23987 Investigation of burning ekibastuz coal in the furnace of the PK-39 steam generator. Mansurov, V.I.; Antonovskii, V.I.; Oslopov, O.I.; Ivanov, S.A.; Kiselev, O.V. *Therm. Eng. (USSR) (Engl. Transl.);* **22**: No. 9, 16-20(Sep 1976).

Translated from Teploenergetika; 22: No. 9, 13-16(Sep 1976).

The combustion of pulverized fuel in vortex burners is described. The nature of gas formation and burnup in the burners is shown graphically. It is shown that the furnace chamber of the steam generator with two tiers of burners with 100 percent supply of the required air is occupied by an active flow in which intense combustion is developed.

23988 Combustion of oil in the furnace of a TPP-210A P.F.-fired steam generator of a 300 MW generating unit. Kruk, M.T.; Prokopenko, A.G.; Kuznetsov, Yu.I.; Polyshev, L.V.; Krasnoshtan, N.N.; Kashchuk, A.D. *Therm. Eng. (USSR) (Engl. Transl.);* **22**: No. 9, 21-24(Sep 1976).

Translated from Teploenergetika; 22: No. 9, 17-19(Sep 1976).

The method ensures efficient combustion of oil in the furnace of a p.f.-fired steam generator without any essential modification. With respect to conditions of operation of the radiant heating surfaces and of the furnace chamber, a single-day cycle is recommended with combustion of anthracite fines and oil (16 h operation on anthracite fines and 8 h operation on oil) within the load range of the furnace of 40 to 75 percent of the rated (200 to 350 t/h), with recirculation of flue gases into the furnace. Long, continuous combustion of oil under conditions of minimal rate of fusion of the slag coat (200 to 230 t/h) for up to 50 to 60 h (time to cover minimum loads on rest-days) may be allowed. In exceptional cases furnace operation for a short time (not longer than 4 h) on oil at a load of 370 to 420 t/h is allowed.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 23962, 24919

23989 Research for coal. Matthoefer, H. (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.)). *Bergbau;* **27**: No. 5, 141-143(May 1976). (In German).

The Federal Minister of Research and Technology, Matthoefer, voices his opinion on the role of coal in the energy program.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 23951, 23953, 23968, 23971, 23972

23990 Jenny Mine: a practical approach to coal mine safety. *Min. Mag.;* **132**: No. 2, 125-129(Feb 1975).

This Kentucky mine is being used by the USBM as a test site for new developments in "conventional" mining systems (i.e., winning with explosives), and in particular FMC's Inherently Safe Mining Systems. Details of the equipment under test are given.

PETROLEUM

23991 (NP—21382) **Selected information resources on petroleum and natural gas.** (Library of Congress, Washington, D.C. (USA). Science and Technology Div.). May 1976. 22p. National Referral Center, Science and Tech., Library of Congress, Washington, DC.

A list of Federal, state, and other information sources on the petroleum and natural gas industries is provided (with addresses). The number of such sources of information totals one hundred. (LTN)

RESERVES

REFER ALSO TO CITATION(S) 24920, 24921, 24922

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 24004

23992 (BERC—0035-12) **Study to determine the feasibility of obtaining true samples of oil or gas reservoirs.** (Maurer Engineering, Inc., Houston, Tex. (USA)). 18 Jan 1977. Contract EY-76-C-02-0035. 12p. Dep. NTIS $3.50.

It is not possible to obtain completely unaltered samples, but 100 percent accuracy is not absolutely necessary and a system can be

developed which will reduce flushing to less than 10 percent. The present Loomis pressure coring system can approach this accuracy. The design of a Phase 1 true fluid coring system and of a more highly sophisticated system (Phase 2) is discussed. (DLC)

23993 (CONF-7410175—5) **Directional acoustic velocity distribution in a petroleum reservoir.** Shuck, L.Z.; Frohne, K.H.; Rennick, G.E.; Evans, D.M. (Bureau of Mines, Morgantown, W.Va. (USA). Morgantown Energy Research Center). 1974. 42p. Dep. NTIS $4.00.

From 49. meeting and exhibition of the Society of Petroleum Engineers of AIME; Houston, Texas, United States of America (USA) (6 Oct 1974).

Experimental conditions, theoretical considerations, and results are given of a directional acoustic velocity survey in the plane of formation of a major oil reservoir in Pennsylvania. Over 60 blasting cap acoustic sources were discharged opposite the Bradford Third sand in 10 different wells located within a 1,200 by 1,600 foot rectangular array of 41 wells. Each source was monitored simultaneously by 11 different hydrophones strategically located within the 41-well array. Both acoustic sources and sensors were located at the formation elevation, nominally 2,000 feet below the surface, so that the in situ velocities determined were in the plane of the sandstone formation. Well-to-well acoustic velocities were calculated and presented in tabular and graphical form. The velocity data were further analyzed statistically to yield overall reservoir velocity trends. Results of the study shows that the reservoir is acoustically very nonhomogeneous with local variations in P-wave velocity as much as 20 percent. The overall P-wave velocity trend for the reservoir was greater in the E-W than the N-S direction by approximately 700 fps. A mean velocity averaged for all wells in all directions was found to be 15,621 fps. Characteristics such as permeabilities, porosities, tectonic stresses, are correlated with the acoustic velocity distribution. (12 fig., 3 tables, 42 references)

23994 (NP—21268) **Analysis of future petroleum development on the Alaskan Outer Continental Shelf, Kodiak area.** O'Connor, F.R.; Dobey, P.L. (Alaska State Dept. of Natural Resources, Anchorage (USA). Div. of Geological and Geophysical Survey). Jun 1976. 36p. Alaska State Dept. of Natural Resources, Anchorage.

Offshore petroleum development scenarios (models) for the Alaskan Outer Continental Shelf, Kodiak area, have been developed for the Alaska Coastal Management Program. A "low and slow" development scenario is compared to a "high and fast" model to give a probable range of future operational events. Graphic flow development models of a hypothetical oil field for each case are presented to give clarity to the scenario process. The High Industry Interest area was used for a base of calculation and prospect estimates ranged from 5 to 30. Oil fields to be discovered are 1 to 10 and reserves located will be between 322 million barrels and 2.5 billion barrels of oil. Evaluation of published information and in-house knowledge were used to give probable estimates for success ratios, wells drilled per year, schedules of exploration and production drilling, exploration and development manning compliments, and other data related to offshore operations.

23995 (ERDA-tr—256) **Paradox of deepwater diagenesis.** Konyukhov, A.N.; Sokolov, B.A. Translated from *Dokl. Akad. Nauk SSSR;* **224**: No. 4, 27-29(1975). 8p. Dep. NTIS $3.50.

Postsedimentation changes originating in the sediment stratum being formed under conditions of uncompensated warping are compared with phenomena studied in profiles of the continental sector of the lithosphere in an environment of compensating sediment accumulation. Results lead to the conclusion that diagenesis in deepwater ocean troughs is, as a rule, uncompleted within the depths accessible in drilling operations. This uncompleted nature forces these deposits to be regarded as of little promise for oil and gas, except for methane precipitated in the form of crystal hydrates. Conditions for extensive oil formation are absent in the deepwater zones of the ocean. (DLC)

23996 **Geological prospecting of petroleum.** Beckmann, H. (Technische Univ. Clausthal, Clausthal-Zellerfeld (Germany, F.R.). Lehrstuhl fuer Erdoelgeologie). Stuttgart, Germany, F.R.; Enke (1976). 191p.

110 figs.; with refs.

This paperback is intended for the purpose of filling the gaps between the extensive, expensive technical manuals and the short comments on practical petroleum geology. It applies to the young geologist, to show him what takes place on the drilling plant and what is expected of him. But also the actively engaged geologist ought to be informed. The eleven chapters of the book treat, among other things, the history of petroleum and petroleum geology, the source and accumulation of petroleum and gas, exploration methods, the practice of deep drilling, slurry gas analysis, stratified examination of drilling material, core drilling analysis, drilling hole measurements, - numerous diagrams supplement the text.

DRILLING AND PRODUCTION

REFER ALSO TO CITATION(S) 23915, 23917, 24931

23997 (BERC/RI—76/13) **Little Tom Thermal Recovery Demonstration Project, Zavala County, Texas. Final report.** Ireton, E.T.; Johnson, F.S. (Hanover Petroleum Corp., Dallas, Tex. (USA); Energy Research and Development Administration, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Jan 1977. Contract EY-76-C-02-0002. 35p. Dep. NTIS $4.00.

The objective of the project was to demonstrate the efficiency and economics of recovering low gravity, viscous crude oil from a relatively thin, low permeability reservoir utilizing a combination thermal drive process in conjunction with thermal stimulation of the producing wells. The combination thermal drive process combines forward in-situ combustion with sequential water injection to provide maximum heat transfer efficiency along the burning front. Thermal stimulation (short-term in-situ combustion at the producing well) allows productivity increases to be realized long before the burning front approaches the producing well. Delays and events caused Phase I of the project to be extended from 4 months to 1½ years. During Phase 1, thermal stimulation operations were conducted on two producing wells, Ned Matthews Nos. 8 and 9. Effort and monies were also expended to upgrade lease and well test facilities, roads and locations, and to obtain a reliable gas supply for compressor fuel and formation ignition operations. The high injection pressures experienced in both wells, sometimes exceeding the 2,000 psig compressor design rating, resulted in frequent injection equipment repairs and high maintenance costs. After the thermal stimulation operations proved unsuccessful, the Little Tom Thermal Recovery Project was terminated. (DLC)

23998 (BERC/TPR—76/4) **El Dorado Micellar-Polymer Demonstration Project. Second annual report, July 1975—May 1976.** Rosenwald, G.W. (ed.). (Cities Service Oil Co., New York (USA)). Jul 1976. Contract E(34-1)-0003. 260p. Dep. NTIS $9.00.

Laboratory oil displacement tests were conducted using Shell Oil Co. and Union Oil Co. chemical formulations in both Berea and El Dorado Admire Sandstone cores. Total relative mobility of the oil-water bank created during chemical flooding was measured in Admire Sandstone cores. The values ranged from 0.018 to 0.065 reciprocal centipoise. Four observation wells were drilled, cored, and logged during the year. They were cased with fiberglass and are now being used to monitor fluid properties. A tracer test was conducted by injection of chemical tracers into each of the 18 injection wells. Results indicate that there is no gross channeling in the reservoir. The same conclusion was drawn from results of interference tests. Performance forecasting was utilized to show that maintaining the bottom-hole injection pressures at 400 psia and the producing pressures at 30 psia would increase throughput rates and result in acceptable project life for the 6.4-acre, five-spot patterns. Injection well rates relative to the central injector were computed. These rates will be used as a guide for the operation of injection wells. This plan corresponds to operation at constant bottom-hole pressures for a homogeneous reservoir of uniform thickness. Construction of the fresh water system and injection plant was completed. The injection plant has performed satisfactorily. Injection of pretreatment fluid was started in both patterns on November 18, 1975.Severe loss of injectivity was experienced during the first week of injection. Several likely causes were identified and corrective actions taken. More moderate injectivity problems have continued throughout this reporting period. Additional preventive measures have been undertaken to improve the quality of injected fluids. A procedure was developed to stimulate and clean-up wells damaged by the injection fluid. A preliminary evaluation indicates that combination solvent-acid treatments will increase injection rates to the desired level.

23999 (CONF-750306—3) **Enhanced oil-recovery methods.** Howell, W.D.; Johnson, F.S.; Johansen, R.T. (Bureau of Mines, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). 1976. 19p. Dep. NTIS $3.50.

From 15. annual ASME symposium; Albuquerque, New Mexico, USA (6 Mar 1975).

The recent changes in availability and the world market price for crude oil have caused the petroleum industry to reevaluate some of the newer, more complicated recovery methods. This report describes three enhanced oil-recovery methods: improved fluid injection, thermal recovery, and miscible-fluid displacement. The principles of each method and the kinds of reservoirs for which they are designed to work are discussed.

24000 (CONF-750493—2) **Laboratory investigation using solvent to recover heavy oil from a fractured reservoir.** Johnson, F.S.; Jones, R.A.; Miller, J.S. (Bureau of Mines, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). 1976. 32p. Dep. NTIS $4.00.

From Meeting of the Society of Petroleum Engineers of AIME; Denver, Colorado, USA (7 Apr 1975).

Laboratory experiments were performed in support of explosive fracturing-solvent injection research in a shallow, heavy-oil reservoir near Bartlett, Kansas. Tests were run on 25 solvents to determine their effectiveness in reducing the viscosity of the 2,820-cp oil and in preventing the precipitation of its 15% asphaltene

content. The commercial solvent selected contains 74.3% aromatics to prevent precipitation; it lowers the oil viscosity to 73 cp when 25% by volume is dissolved in the oil. Fifteen oil recovery experiments were performed on lease cores using the solvent selected. Four solvent-soak experiments, simulating solvent injection into a fractured reservoir, showed that increasing soaking time, surface-to-volume ratio, oil saturation, and temperature increased the amount of oil recovered per pore volume produced. Five solvent flooding experiments demonstrated the difficulty of forcing solvent through the highly oil saturated cores and the increased recovery rate caused by reversing flow. Five alternate water-solvent injection experiments, while using less solvent, averaged 10% less recovery than the solvent flood experiments. One experiment showed that continuous recirculation of the solvent could recover similar amounts of oil with less solvent than the solvent-soak experiments. 8 figures.

24001 (CONF-760237—) **Symposium on stimulation of low permeability reservoirs.** (Colorado School of Mines, Golden (USA); American Gas Association, Inc., New York). 1976. 171p. Colorado School of Mines, Golden, CO.

From Symposium on stimulation of low permeability reservoirs; Golden, Colorado, United States of America (USA) (16 Feb 1976).

Separate abstracts have been prepared for the ten papers printed in full in the proceedings. Topics covered include fracturing fluids, massive hydraulic fracturing, nuclear stimulation, foam, acid, temperature/gamma ray logging for analysis of fracture placement, etc. (DLC)

24002 (CONF-760237—, pp 72-86) **Low concentration hydrochloric-hydrofluoric acid mixtures for stimulation in low porosity, low permeability sandstone formations.** Holcomb, D.L. 1976.

From Symposium on stimulation of low permeability reservoirs; Golden, Colorado, United States of America (USA) (16 Feb 1976).

In Symposium on stimulation of low permeability reservoirs.

HCl—HF mixtures have long been topics of investigation with respect to the optimum concentrations necessary for effective stimulation of low-porosity, low-permeability sandstone reservoirs. Low concentrations of HCl and HF in combination with one another (i.e., 3 percent HCl + 0.6 percent HF) provide a highly efficient system whereby less damaging reactions occur in the sandstone matrix or fracture system, thus reducing the damage caused by migrating and sloughing fines produced when conventional HCl—HF systems (i.e., 12 percent HCl + 3 percent HF) are used. In addition, the ability of the low concentration HCl—HF system to overcome the capillary imbibition effects, which tend to reduce the efficiency of load fluid recovery following stimulation of a low porosity, low permeability sandstone reservoir, is enhanced by using ultra low surface tension reduction via the application of a low adsorption, cationic, fluorocarbon surfactant. Coreflow studies illustrate the above mentioned principles. (7 tables)

24003 (CONF-760237—, pp 105-134) **Incorporation of temperature with gamma ray logging techniques in analyzing fracture placement.** Blanks, G.L. 1976.

From Symposium on stimulation of low permeability reservoirs; Golden, Colorado, United States of America (USA) (16 Feb 1976).

In Symposium on stimulation of low permeability reservoirs.

Temperature control logging is used to divide hydraulic fracturing treatments in oil fields into stages. The temperature logs are difficult to interpret at times, and radioactive tag sand was introduced during the frac process and the radioactive log incorporated with the temperature log. Advantages of the combined method and examples of its application and performance are given. (20 fig.) (DLC)

24004 Study on water flood processes in reservoirs in oil fields in Tataria by geophysical exploration methods. Muslimov, R.Kh.; Orlinskij, B.M.; Sultanov, S.A. pp 275-280 of In Razvedochnaya geofizika SSSR na rubezhe 70-kh godov. Moscow; Nedra (1974). (In Russian)

From 7. all-union scientific and technological geophysical conference; L'vov, Ukrainian SSR (15 Nov 1972).

Laterolog data are used to find the initial water-oil interface in uncased boreholes. Oil-bearing, water-saturated and highly mineralized water-flooded reservoir rocks are localized with neutron logging techniques in cased non-perforated boreholes. Taking periodic measurements with pulsed neutron-gamma logging, pulse neutron-neutron logging and other neutron logging techniquews in the same borehole, the flooding of the reservoir rock in thickness, the ascensional rate of the water-oil interface, the flooding front configuration at the mining sites are evaluated. In perforated boreholes the stratum being flooded is localized using the results obtained from the investigation of the composition and the rate of fluid flow in the borehole with a dielectric hygrometer, a gamma-gamma densitometer and a well-head flow meter. Geophysical methods of localizing flooded spaces based on differences in the rate of the elimination of the penetration zone in oil- and water-bearing reservoir rocks have been developed and applied in the Tatar ASSR.

24005 (ERDA-tr—257) **Concerning the mutual solubility of water and oil.** Oganov, K.A. Translated from *Neftеprom. Delo;* No. 12, 27-29(1975). 7p. Dep. NTIS $3.50.

It was established by laboratory experiments on a model porous sandstone saturated by oil, that total displacement of the oil by water is possible using water at 300 to 320°C and 200 to 210 kg/cm² pressure. Total oil displacement can also be obtained using an admixture of water and CO_2 at 260°C and 210 kg/cm². Stratification of the oil-water solution occurs as the solution temperature is decreased. On account of the pressure, the depth of the bed must be at least 1800 m. Calculations are presented for the temperature-depth relation of water-steam in well simulation. (DLC)

24006 Enhanced recovery in Alberta: a review, and the role of the Energy Resources Conservation Board. Govier, G.W. (Dept. of Energy and Natural Resources, Alberta). *J. Can. Pet. Technol.;* **15**: No. 3, 13-19(1976).

There are opportunities to encourage or assist enhanced recovery from the time of initial development until abandonment of an oil pool. The Energy Resources Conservation Board has developed a data base and, in consultation with industry, has evolved a system of regulations and procedures that play a significant role in the development of optimum enhanced recovery operations. Among the effective incentives has been the proration plan whereby production is allocated largely in proportion to recoverable reserves. Some 11.5 of the 35.5 billion barrels of initial proved oil in place in Alberta is recoverable by methods currently being applied. About one-third of the proved initial recoverable reserves is the result of enhanced recovery operations. The remaining 24.0 billion barrels presents a substantial challenge. The Energy Resources Conservation Board, industry, and the Alberta Government have initiated an extensive research program in Alberta with a view to increasing the portion of the in-place reserves which is recoverable. Economic incentives are equally important in increasing oil recovery and also are being reviewed.

24007 Current and required economics in relation to further Alberta enhanced recovery of conventional crude. Millard, V.; Berndtsson, N.G.; Bray, J.A. (Energy Resources Conservation Board, Calgary, Alberta). *J. Can. Pet. Technol.;* **15**: No. 3, 20-31(1976).

The status of Alberta crude oil reserves is reviewed briefly in respect to currently established recovery factors and the technical potential for additional recovery enhancement. A hypothetical pool is evaluated, with consideration given to the economics of pressure maintaining the pool by waterflood, solvent flood, and micellar solution flood. In each case, the technology is assumed to be proven and the recovery factor for each mechanism is established at a level generally believed applicable for a flood of that genre. The technical practicality of "exotic" depletion schemes is considered in terms of the need to proceed with the exotic scheme early in the producing life of the pool. Economic calculations for the hypothetical pool show that exotic schemes frequently cannot compete economically with waterflood operations. Therefore, under current economic conditions, exotic recovery is normally not feasible and, where it is feasible, would proceed only after the waterflood reserves of the pool have been totally, or almost totally, recovered. This deferment could seriously reduce the incremental tertiary economics to the point of making tertiary recovery entirely impractical. Consideration is given to methods of improving the economic attractiveness of enhanced recovery schemes through royalty and tax relief. A simplified costbenefit analysis of the impact of such relief is presented.

24008 Effect of heterogeneous wettability on flow of fluids through porous media. Singhal, A.K.; Mukherjee, D.P.; Somerton, W.H. (Univ. of California, Berkeley). *J. Can. Pet. Technol.;* **15**: No. 3, 63-70(1976).

In order to study the effect of heterogeneous wettability on the multiphase flow behavior, porous samples were prepared by mixing teflon powder and glass beads in different ratios. Flow and displacement tests were conducted using different fluid pairs, so that the effects of heterogeneous wettability would be tested over a large range of physical properties of the solid-fluid system. It was found that as the fraction of surface wetting to the displaced phase increased, the ultimate recovery decreased linearly. There appeared to be a poor correlation between the ultimate recovery and Cassie's equivalent contact angle and the latter did not seem to be an adequate index of heterogeneous wettability. Also, as the wettability to the displaced phase increased the relative permeability ratio curve was found to shift, resulting in a higher residual saturation of the displaced phase. Interfacial tension was shown to have the maximum influence on recovery, higher recovery being obtained at lower interfacial tension. There appeared to be an effect of viscosity ratio on the vertical position of relative permeability ratio curves, but not on ultimate recovery. 31 references.

24009 Interfacial tensions and aging behavior of some crude oils against caustic solutions. McCaffery, F.G. (Petroleum Recovery Inst., Calgary, Alberta). *J. Can. Pet. Technol.;* **15**: No. 3, 71-74(1976).

Interfacial tensions between sodium hydroxide solutions and four crude oils were measured as a preliminary step in the investigation of caustic waterflooding possibilities. Based on these initial results and some laboratory caustic flood tests reported in the literature, the Wainwright and Viking Kinsella Wainwright B heavy oil reservoirs are possible candidates for improved oil recovery by caustic waterflooding. Core displacement measurements or pilot floods will, however, be required to evaluate actual benefits from the process. A minimum interfacial tension between these heavy oils and caustic solutions occurs with about 0.25 wt. percent NaOH in injection water. The interfacial tension between the crude oils and sodium hydroxide solutions was found to increase with the age of the interface. This behavior suggests that many of the sodium soap products, which are formed when acidic compounds in the crude oil react at the interface with sodium ions in the aqueous phase, subsequently migrate away from the oil/water interface. 25 references.

24010 Production increase of heavy oils by electromagnetic heating. Abernethy, E.R. (Dome Petroleum Ltd., Calgary, Alberta). *J. Can. Pet. Technol.;* **15**: No. 3, 91-97(1976).

Several methods of accelerating oil flow by applying heat from the wellbore to the reservoir have been successfully field tested. However, it appears that the possibility of heating by high-frequency radiation has not been extensively investigated, either theoretically or experimentally. The concepts involved are discussed, and a mathematical model is developed in order to evaluate the temperature distributions and other physical effects resulting from the radiation of electromagnetic energy into an oil reservoir. Flow performance is compared to the unheated case on the basis of a steady-state temperature distribution, which is derived. The results of a pre-steady-state transient flow condition are also presented. Calculations based on the mathematical model developed indicate that further work is warranted to prove or disprove the feasibility of this method of stimulation. A brief discussion of completion and engineering problems is included.

24011 20 years experience with water flooding in the Federal Republic of Germany. Ruehl, W. (Deutsche Texaco A.G., Hamburg (Germany, F.R.)). *Erdoel-Erdgas Z.;* **92**: No. 9, 311-319(Sep 1976). (In German).

From Spring meeting of the DVGI; Clausthal-Zellerfeld, Germany, F.R. (30 Apr 1976).

14 figs.; 6 tabs.; with refs.

In the introduction, aims, problems and limits of water flooding are described. The field examples Hohne, Hankensbuettel-Sud and Plon-Ost illustrate the practice of water flooding in the Federal Republic of Germany. Output and injection of water in the Federal Republic of Germany are combined as a comparison of the years 1964 and 1974 and tabulated in cumulated form (December 31st, 1974), just as is done with the evaluation of first and secondary oil extractions from all oil fields in the Federal Republic. A further chapter deals with the processing flood water. Diagrams which illustrate the development of output and deposits complete the work.

24012 Flood nears production response. Walker, C.J.; Burtch, F.W.; Thomas, R.D.; Lorenz, P.B. (Energy Res and Dev Adm, Bartlesville, Okla). *Oil Gas J.;* **74**: No. 39, 60-68(27 Sep 1976).

Enhanced oil production is expected to begin in October from a pilot micellar flood in an Oklahoma stripper field. Oil production should increase with only minor dips for 1 1/2 to 2 years to the maximum production rate of 35 bo/d from the four producing wells in the 2 1/2-acre test site. Tertiary oil should be produced for more than four years. An extensive laboratory and field study of fluid and rock chemistry, as well as some other factors involved in the project are detailed. 6 refs.

PROCESSING

REFER ALSO TO CITATION(S) 24980

24013 Method and equipment to control the catalytic cracking of hydrocarbons. Gorring, R.L. (to Mobil Oil Corp.). German(FRG) Patent 1,645,766/C/. 27 Feb 1975. 11p. (In German).

2 figs.; 4 tabs. Available from Dt. Patentamt, Muenchen (FRG).

The object of the invention is to obtain a method and equipment with which one can automatically control the course of the catalytic cracking of hydrocarbons in a regenerating process, in which the catalyst is led in cycle, without undesired changes of the quality of the cracked products.

24014 Method for the production of a catalyst for the vapor reformation of hydrocarbons. Kondo, K.; Sato, F.; Fujino, S. (to Japan Gas-Chemical Co.). German(FRG) Patent 1,767,516/C/. 5 Feb 1976. 5p. (In German).

3 tabs. Available from Dt. Patentamt, Muenchen (FRG).

The invention deals with a method to produce a catalyst containing a nickel compound and cement for the vapor reformation of hydrocarbons in which a mixture of the nickel compound and the cement is heated. The problem is thus solved in that the mixture, containing 3 to 40 weight percent nickel, is heated at a temperature of 400 to 700°C under a hydrogen gas stream which contains less than 10% hydrocarbon, carbon dioxide and carbon monoxide gases.

24015 Heavy crude conversion. Arey, W.F. Jr.; Hamner, G.P.; Sawyer, W.H. (to Exxon Research and Engineering Co.). US Patent 3,985,684. 12 Oct 1976. Filed date 16 Dec 1974. 42p.

Two distinct types of catalysts useful for the catalytic hydroconversion of the 1050°F+ hydrocarbon material contained in heavy crudes and residual fuels are discussed. The resultant product from the catalytic hydroconversion will be suitable for further processing in conventional refinery operations allowing maximization of clean liquid products. Catalysts which include Group VIB and Group VIII metals, preferably in admixture, and preferably including a Group IVA metal, notably germanium, having certain critical ranges of physical characteristics inclusive of large uniform pore sizes, are used for the conversion. Novel methods are described for the preparation of such catalysts, as well as for use of such catalysts. One of the catalysts i.e., one having properties inclusive of a large number of pores in the 100-275A pore size diameter range, is particularly suitable as a first stage catalyst and the other, which has properties inclusive of a large number of pores in the 100-200A pore size diameter, is especially suitable as a second stage catalyst for use in processing the effluent of said first stage. 16 Claims, No Drawings.

24016 Surplus distillation capacity. EC study estimates a medium-term surplus of 20-30%. *Oel;* **14**: No. 9, 247-252(Nov 1976). (In German).

5 tabs.

This is a report on a study dealing with the situation of crude oil processing in relation to the present markets within the EC. The probable course of development up to 1980 or, in same cases, up to 1985, is sketched. It is found that there will be a surplus distillation capacity of 20-30% in Europe within the next 5 years. The refinery structure in the EC, the mineral oil demand from 1975 to 1980 and the coverage of demands are given in tables.

PRODUCTS AND BY-PRODUCTS

24017 (CONF-750410—13) Analytical method for the characterization of nitrogen bases in high-boiling petroleum distillates. McKay, J.F.; Latham, D.R. (Bureau of Mines, Laramie, Wyo. (USA). Laramie Energy Research Center). 1976. 19p. Dep. NTIS $3.50.

From 169. national meeting, American Chemical Society; Philadelphia, Pennsylvania, USA (6 Apr 1975).

The major basic compound types in eight high-boiling crude oil distillates were identified as pyridine benzologs, diaza compounds, amides, and carbazoles. Bases from crude oils having different geological characteristics were separated using a standardized separation scheme. The separation scheme involved the use of ion exchange and adsorption chromatography. Quantitative infrared analysis was used to determine the relative amounts of compound types; these results were correlated with titration and total nitrogen data. The structures of the base compounds were examined in detail, using mass fluorescence and infrared spectrometry.

24018 Method to produce benzine and refined liquid hydrocarbons. Peterson, A.H.; Dormish, F.L. (to Marathon Oil Co.). German(FRG) Patent 2,215,665/C/. 23 Jan 1975. 8p. (In German).

3 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention deals with a method to produce benzine and refined liquid hydrocarbons starting with a total crude oil or a crude oil, which is distilled by removing a fraction boiling below 200°C, by means of cracking in a catalytic cracking equipment.

24019 Catalytic cracking process to produce benzine. Kimberlin, C.N. Jr.; Gladrow, E.M. (to Exxon Research and Engineering Co.). German(FRG) Patent 2,404,205/A/. 31 Jul 1975. 25p. (In German).

2 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention deals with an improved catalytic cracking process to produce benzine, which has a high octane number (high octane benzine) without lead coating. This enables one to obtain high octane benzine in high yields in combination with a naphtha reformation.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 24007, 24925, 24926, 24927

24020 (NP—21323) Sales of fuel oil and kerosine in 1975. (Bureau of Mines, Washington, D.C. (USA)). 17 Sep 1976. vp. Bureau of Mines, Washington, DC.

Domestic sales of distillate fuel oils, residual fuel oils, and kerosine (excluding jet fuel) decreased from 2,109 million barrels in

1974 to 1,997 million barrels in 1975. This 5.3 percent decrease was reflected primarily in the heating, electric-utility, and transportation use categories, according to the Bureau of Mines, United States Department of the Interior.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 23950

24021 (CONF-750530—4) **Combined biological treatment and underground injection of refinery waste water.** Sutterfield, F.D.; Donaldson, E.C.; Mannning, F.S. (Bureau of Mines, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). 1976. 26p. Dep. NTIS $4.00.

From 2. national conference on complete water use; Chicago, Illinois, USA (4 May 1975).

A petroleum refinery wastewater is split into two streams. Biological treatment is used for 6.3 million gallons per day for 150 ppM five-day biological oxygen demand (BOD_5) waste, and the remaining 0.4 million gallons per day of wastewater, containing ammonia, mercaptans, phenol, and sulfides with a 4,000 ppM BOD_5, is injected into a 7,000-foot-deep geologic formation. Both treatment systems and a possible redesign of the biological unit to include the high BOD_5 waste are described. The biological and underground waste injection systems meet current legal requirements for waste processing, and the combined system is more economical than treatment in a single biological system. 6 fig, 6 tables.

ENVIRONMENTAL ASPECTS

24022 Toxicity of some formation fluids and methods of rehabilitation subsequent to their spillage. Shaw, D.R. (Energy Resources Conservation Board, Edmonton, Alberta). *J. Can. Pet. Technol.;* **15**: No. 3, 37-41(1976).

This paper deals with the effects that formation fluids have on animal and plant life. Crude oil is a mixture—not only of hydrocarbons, but of suspended salts and of sulfur compounds. The toxicity of some of the hydrocarbons and some of the sulfur compounds is discussed, as is the toxicity of salt. Consideration is also given to the complexity of the hydrocarbon components and the influence of refining methods on toxicity. Some mechanisms by which an animal system may attempt to overcome injurious effects are outlined. Finally, methods of aiding recovery are suggested. 26 references.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 24920, 24921, 24922, 24923, 24924, 24925, 24926, 24927, 24928, 24930

24023 (NP—21264) **Alaskan oil demand 1975—2000. Report No. 91.** Bewley, G.; O'Connor, K.; Dobey, P.L.; Welch, J.; Klein, R.; McConkey, W.; Quilan, C. (Alaska State Dept. of Natural Resources, Anchorage (USA). Div. of Geological and Geophysical Surveys; Alaska State Energy Office, Anchorage (USA)). Aug 1975. 30p. Alaska State Dept. of Natural Resources, Anchorage.

Each demand analysis consists of a scenario or set of general circumstances that would logically cause certain reactions from the primary demand parameters; population, per capita consumption, price, rationing, alternative energy use, industrial effects and miscellaneous. These scenarios then set the scene for the researched inputs to the computer. All inputs were in the form of a triangular probability distribution. Generally, the results indicate that it will be nearly impossible to consume all of the royalty oil from today's known reserves in the state before 1990. After 1990, unless there is a low consumption rate or new royalty reserves have been found, internal oil consumption will exceed a value greater than the royalties.

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 24929

24024 Proposed pipeline across the Norwegian Trench. Lund, S. *Meerestechnik;* 7: No. 5, 165-172(Oct 1976). (In German).

12 figs.

One of the possible solutions for transportation of the crude oil from the Statfjord field is by pipeline to Norway. Such a pipeline will have to cross the Norwegian Trench at a maximum waterdepth of about 330 meters, which is about twice the depth of the present deepest pipelines in the North Sea. A study on alternative crude oil transportation systems was carried out in 1975 by Statoil on behalf of the Statoil-Mobil group. This study included a 36-inch pipeline to Norway. If the pipeline development program is chosen and this results in a decision for the pipeline early 1978, 1980 is expected to be the lay season, with the line operational at the end of 1981.

PROPERTIES

REFER ALSO TO CITATION(S) 24017

24025 (BERC/PPS—77/1) **Motor gasolines, summer 1976.** Shelton, E.M. (Energy Research and Development Administration, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Jan 1977. 80p. Dep. NTIS $5.00.

Analytical data for 2,949 samples of motor gasoline, from service stations throughout the country, were collected and analyzed. The samples represent the products of 53 companies, large and small, which manufacture and supply gasoline. These data are tabulated by groups according to brands (unlabeled) and grades for 17 marketing areas and districts into which the country is divided. A map shows marketing areas, districts, sampling locations. The report also includes charts indicating the trends of selected properties of motor fuels since 1946. Twelve octane distribution percent charts for areas 1, 2, 3, and 4 are unleaded, regular, and premium grades of gasoline are presented in this report. The antiknock (octane) index [(R + M)/2] averages of gasolines sold in this country were 88.2, 89.6 and 95.2 for unleaded, regular, and premium grades of gasolines, respectively. 14 figures, many tables.

24026 (CONF-741042—2) **Application of liquid chromatography to high-boiling petroleum distillates.** Latham, D.R. (Bureau of Mines, Laramie, Wyo. (USA). Laramie Energy Research Center). 1976. 20p. Dep. NTIS $3.50.

From 8. conference on analytical chemistry in nuclear technology and exhibition; Gatlinburg, Tennessee, USA (22 Oct 1974).

Systematic application of ion-exchange, coordination-complex, and adsorption chromatography was used to separate high-boiling distillates into acid, base, neutral nitrogen, saturate, and aromatic fractions. The acid, base, and neutral nitrogen fractions were further separated by adsorption, gel-permeation, and thin-layer chromatography to give concentrates that were amenable to detailed characterization of the compound types present in each fraction. Analytical data obtained from the separation and characterization of the distillates gives important information about their compound-type composition.

24027 Scaled fluid-flow with permeabilities differing from that of the prototype. Bentsen, R.G. (Univ. of Alberta, Edmonton). *J. Can. Pet. Technol.;* **15**: No. 3, 46-52(1976).

Laboratory studies, if they are to be useful in predicting fluid flow behavior in petroleum reservoirs, must be scaled. One of the more difficult scaling requirements to meet is that the relative permeabilities must be the same functions of saturation in the model and prototype. This paper shows that this restriction may be eliminated, provided certain conditions are met. In particular, the breakthrough displacement efficiency in a linear system may be considered to be a function of mobility ratio only, provided the transition zone is short, and provided the assumptions underlying Buckley-Leverett theory are not seriously violated. The paper also demonstrates that evaluating the displacing-phase mobility at the average saturation in the swept region is equivalent (albeit approximately) to accounting for two-phase flow in that region.

24028 Analysis of acids in high-boiling petroleum distillates. McKay, J.M.; Cogswell, T.E.; Weber, J.H.; Latham, D.R. *Fuel;* **54**: 50-61(Jan 1975).

This paper describes the investigation of acids in crude oils from different geological sources. The major acidic compound types in ten high-boiling crude-oil distillates were identified as carboxylic acids, phenols, carbazoles, and amides. Three methods were used for the quantitative estimation of major compound types; the compound types were determined gravimetrically after chromatographic separation and by two qualitative infrared methods. The structures of the acidic compounds were also examined in detail using fluorescence, mass, infrared, and nuclear magnetic resonance spectrometry.

24029 New displacement capillary pressure model. Bentsen, R.C. (Univ. of Alberta, Edmonton); Anli, J. *J. Can. Pet. Technol.;* **15**: No. 3, 75-79(1976).

A capillary pressure function for porous media (commonly known as the J-function) was postulated by Leverett and has been widely used for correlation purposes. It is generally accepted, however, that the J-function correlates satisfactorily only the data from unconsolidated sands and from the same formation. It is the purpose of this study to formulate a new drainage capillary pressure function which would overcome this restriction. The proposed model is a function of saturation and involves three parameters which have to be obtained experimentally. The model has been experimentally

verified using data obtained from relatively homogeneous, water-wet, artificially consolidated silica cores, and using several different fluid combinations. This limited amount of experimental data suggests that the correlation may prove to be universal for relatively homogeneous and isotropic materials.

COMBUSTION

REFER ALSO TO CITATION(S) 23988

NATURAL GAS

REFER ALSO TO CITATION(S) 23991, 24221, 24936

24030 **Gas deficit.** Reichardt, P.E. (Washington Gas Light Co., DC). pp 49-60 of In Capturing the sun through bioconversion. Washington, DC; Washington Center (1976).

From Conference on capturing the sun through bioconversion; Washington, District of Columbia, United States of America (USA) (10 Mar 1976).

See CONF-760354—.

The interest of the natural gas industry has focused on its development of a nationwide transport system that can be used for both natural and substitute gas. Therefore, it is participating in efforts to develop new sources of SNG. Deregulation is another area of prime importance. It is the belief of the industry that sufficient proven and undiscovered reserves exist to supply the nation adequately until proven SNG technology is developed. (JSR)

RESERVES

REFER ALSO TO CITATION(S) 24222

24031 (NP—21348) **Gas reserve estimation of offshore producible shut-in leases in the Gulf of Mexico.** (National Academy of Sciences - National Research Council, Washington, D.C. (USA). Board on Mineral Resources). Mar 1976. 179p. National Academy of Sciences, Washington, DC.

In response to a directive from Rogers B. Morton, Secretary of the Interior, Vincent E. McKelvey, Director of the U.S. Geological Survey, requested the National Research Council to conduct an evaluation of the estimating techniques and procedures and of the gas reserve estimates for a representative sample of the 168 shut-in producible leases in the Gulf of Mexico which had been reported in an analysis by the Federal Power Commission. The Panel selected a representative sample of 33 leases for detailed study and engaged two consulting firms with extensive experience in the offshore region to make independent "best," "high," and "low" estimates of physically recoverable gas utilizing only those data available to the FPC staff at the time of its analysis. Resulting comparative figures show that for almost all individual leases, the total amounts of gas reported by the FPC are from two to three times higher than estimates of either of the consultants. Excluding errors, the major differences in estimates of recoverable gas were due to interpretation of geological data in developing estimates of reservoir volume and the fraction of gas that could be physically recovered from a reservoir. The Panel also gave attention to the use of misleading terminology in the FPC report, noting that the terms reserves, paying quantities, and producible were used in a special sense not in accord with the generally accepted meaning of the terms. Thus, according to usage of terms in the FPC report, a statement on gas reserves in paying quantities on producible shut-in leases refers to gas which is physically recoverable in theory, without regard for economic considerations, from wells which may or may not be possible to relocate or re-enter.

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 23992, 23995

24032 (MERC/TPR—76/9) **Lithologic description of cored wells No. 20402 and No. 20403 in the Devonian shale in Lincoln County, West Virginia.** Byrer, C.W.; Vickers, M.K.; Rhoades, S.J.; Easterday, B.G. (Energy Research and Development Administration, Morgantown, W.Va. (USA). Morgantown Energy Research Center). Oct 1976. 62p. Dep. NTIS $4.50.

A detailed lithologic description of the Upper Devonian Shale as observed in cores taken from two wells near Ranger, Lincoln County, West Virginia is presented. One of the cored wells, No. 20402 (West Virginia Permit No. 1636), is located approximately three miles southwest of Ranger, West Virginia on Ten Mile Creek while the second cored well No. 20403. (West Virginia Permit No. 1637), is located near the first well, but is located on Fourteen Mile Creek. Analysis of the core material is providing information to be used in designing stimulation techniques for the improvement of gas production from the Devonian Shale. (JRD)

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 23915, 23967, 23971

24033 (NP—21267) **Projected Alaskan royalty gas production and its relationship to projected natural gas demand.** Dobey, P.L.; O'Connor, K.M.; Gilbreth, O.K.; Miller, J.C.; Hamilton, H.H. (Alaska State Dept. of Natural Resources, Anchorage (USA). Div. of Geological and Geophysical Survey). Apr 1976. 37p. Alaska State Dept. of Natural Resources, Anchorage.

Using conservative parameters for the natural gas surplus analysis, a Prudhoe Bay field royalty surplus above residential-commercial needs was found for all pipeline capacities. When the more probable pipeline throughputs are considered (2.0 and 2.5 billion cubic feet per day), surpluses of over 70 percent of the pipeline royalty capacities are present until 1990. The probable effect of future estimated energy production and proven additional gas reserves will insure a surplus above 90 percent of royalty gas for the entire twenty-year period in the 2.0 Bcf per day and 2.5 Bcf per day cases. The assumption that royalty gas will be needed to supply future power demands in the greater Anchorage area must be weighted against the high probability that additional coal-fired generators and hydroelectric power development will be available. After the present commitments of working gas are exhausted, the probable addition of a new alternate energy source added to the likelihood of additional commitments of working gas being acquired by suppliers would insure a solid royalty surplus after 1990.

ENVIRONMENTAL EFFECTS

REFER ALSO TO CITATION(S) 24022

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

REFER ALSO TO CITATION(S) 23968, 24001

24034 (BERC—0033-7) **Pinedale unit MHF experiments. Final report.** (El Paso Natural Gas Co., Tex. (USA)). Oct 1976. Contract EY-76-C-02-0033. 36p. Dep. NTIS $4.00.

Three MHF experiments have been performed in a tight reservoir in the Northern Green River Basin at depths between 8,000 and 12,000 feet. A total of 894,190 gallons of fluid and 2,715,000 pounds of sand were pumped in three stages in two wells with the limited entry technique. Fluid viscosities were designed to give propped lengths of 1,000 to 1,500 feet and proppant sand beds having heights greater than 50 percent of the thickness of each sandstone fractured. The experiments included laboratory research to design limited entry with perforations through one and two strings of casing. Field data analysis to determine fracture gradients and extent of perforation erosion has been complicated by a dependence of friction pressure in tubular goods upon sand concentration and by an apparent large variation in minimum principal in-situ stress between sandstones simultaneously fractured with the limited entry technique. A high proppant concentration was used to assure that production would be limited to reservoir characteristics, rather than fracture conductivity. Comparison was made with results of prior hydraulic fractures propped with a partial monolayer. Resulting production capacity to date has been only about one-fifth that projected in the National Gas Survey report. Evaluation of the resulting production capability and the cost of the hydraulic fracture treatmnet indicates that the stimulation technique employed is not commercially feasible at this time for the reservoir conditions tested. 10 fig, 6 tables.

24035 (CONF-760237—, pp 1-13) **Properties of various FRAC fluids as compared to the ideal fluid.** White, J.L.; Free, D.L. (Dow Chemical Co., Golden, CO). 1976.

From Symposium on stimulation of low permeability reservoirs; Golden, Colorado, United States of America (USA) (16 Feb 1976).

In Symposium on stimulation of low permeability reservoirs.

Many new fracturing fluids have been developed to improve the fracturing process. However, many improvements still can be made in achieving the ideal frac fluid. Some of these improvements await better analysis of fracturing results and before-fracturing po-

tential to compare present fluids and to define future requirements. Identification of fracture geometry and a better understanding of rock mechanics and design criteria will also be required. For deeper reservoirs, propping agents, as well as fluids, must be improved. With the long treating times required in MHF (massive hydraulic fracturing), careful attention to design of fluid stability and proper breaker application is essential. Of current fluids, the highly efficient crosslinked gels and emulsions are best suited for MHF of low permeability sandstone reservoirs. In shallow wells, foams may find application. The fluid properties where the greatest improvements may be possible are ease and reliability of mixing, fluid loss efficiency, and minimizing production impairment. (7 fig.)

24036 (CONF-760237—, pp 16-27) **Design, logistics, and implementation of a massive hydraulic FRAC job in the Denver—Julesburg Basin. Part II. The service company.** Stennis, G.G. 1976.

From Symposium on stimulation of low permeability reservoirs; Golden, Colorado, United States of America (USA) (16 Feb 1976).

In Symposium on stimulation of low permeability reservoirs.

Through close cooperation of the well operator and the service company, the successful performance of a massive hydraulic fracturing (MHF) job is virtually assured. Great advances in equipment design and availability have helped make this possible. Among the biggest problems in MHF is the handling of the huge amounts of material involved. Special care must be taken in the control of the properties of the fracturing fluid. The control of bacteria in water-based fluid is especially important. Also especially important in these jobs is the provision of additional cooling and lubrication system capacity for engines, transmissions, and transfer boxes. (6 fig.)

24037 (CONF-760237—, pp 28-42) **Status report on the three nuclear experiments for stimulation of tight gas sands.** Luetkehans, G.R. (CER Geonuclear Corp., Las Vegas, NV); Toman, J. 1976.

From Symposium on stimulation of low permeability reservoirs; Golden, Colorado, United States of America (USA) (16 Feb 1976).

In Symposium on stimulation of low permeability reservoirs.

The three experiments discussed are: Project Gasbuggy (Dec. 10, 1967), Project Rulison (Sept. 10, 1969), and Project Rio Blanco (May 17, 1973). The information obtained from the experiments indicates that nuclear gas stimulation is feasible. Much of the excessive cost of the experiments was due to environmental and safety concern, legal action, political opposition, etc. Various factors make further development of this stimulation method unlikely. (7 fig.) (DLC)

24038 (CONF-760237—, pp 63-71) **Design, logistics, and implementation of a foam-FRAC job.** Abbott, B. 1976.

From Symposium on stimulation of low permeability reservoirs; Golden, Colorado, United States of America (USA) (16 Feb 1976).

In Symposium on stimulation of low permeability reservoirs.

The properties of foam make it an ideal fluid for stimulating low permeability reservoirs, formations severely damaged by water, and formations which are difficult to clean up. Foam properties are used with conventional design techniques, and operational procedures do not differ significantly from those employed when fracturing with conventional fluids.

24039 (CONF-760237—, pp 87-104) **Performance and cost of massive hydraulic fracturing in the Wattenberg Field.** Covlin, R.J.; Fast, C.R.; Holman, G.B. 1976.

From Symposium on stimulation of low permeability reservoirs; Golden, Colorado, United States of America (USA) (16 Feb 1976).

In Symposium on stimulation of low permeability reservoirs.

Results of a joint research and field effort to develop commercial gas production from the very low permeability Muddy "J" Formation (50 ft thick, 8,000 ft depth) in the Wattenberg Field near Denver, Colorado, by the application of MHF (Massive Hydraulic Fracturing) are presented. Initial attempts to develop the gas potential in this field by stimulating wells with 40,000 to 50,000 gal gelled water fracturing treatments resulted in increased gas production, which however rapidly declined with time. Laboratory studies were made to evaluate various fracturing fluids and proppant plans. A stimulation program was developed which utilized a polymer emulsion fracturing fluid. Treatments with up to 500,000 gal of fluid and 1,000,000 lb sand have been conducted. Field case histories are discussed and the results of MHF treatments are compared with the conventional fracturing treatments. It was found that the well and treatment payout time was inversely proportional to the treatment size in the better areas of the field, showing that the larger treatments are more desirable. In the poorest areas of the field, well and treatment payout is indefinite at the current interstate gas price. (10 fig.) (DLC)

24040 (CONF-760237—, pp 139-160) **MHF research in the Green River Basin.** Randolph, P.L. (El Paso Natural Gas Co., TX). 1976.

From Symposium on stimulation of low permeability reservoirs; Golden, Colorado, United States of America (USA) (16 Feb 1976).

In Symposium on stimulation of low permeability reservoirs.

In 1972, the FPC Natural Gas Technology Task Force studied the potential for production from tight Fort Union/Mesaverde sandstone reservoirs in three Rocky Mountain basins, and concluded that 40 to 50 percent of the estimated 600 trillion cubic feet (tcf) of the gas-in-place could be recovered by nuclear explosive fracturing or massive hydraulic fracturing (MHF). El Paso performed three MHF experiments in the Pinedale Unit area in the northern part of the Green River Basin, which contains 240 of the 600 tcf gas-in-place. This paper discusses these experiments, compares the preliminary results with Task Force projections, and identifies technical issues. (8 fig.) (DLC)

24041 (CONF-760237—, pp 165-174) **Fracturing techniques in the Mississippian trend.** Hannah, R.R. (Western Co. of North America, Fort Worth, TX). 1976.

From Symposium on stimulation of low permeability reservoirs; Golden, Colorado, United States of America (USA) (16 Feb 1976).

In Symposium on stimulation of low permeability reservoirs.

Both field experience and theoretical investigation show that significant pressure response can be generated by the use of a viscous gel. The deep penetration of this blocking mechanism is valuable in preventing early bypass of stimulation fluid around the block. The length of the plug can be controlled. Because of the high friction drops experienced in the pipe, requirements for its use are low fracture gradients, adequate pipe size, and moderate depth. (DLC)

24042 (ERDA-tr—255) **Use of aqueous surfactant solutions for increasing the gas yield from wells.** Selyutin, P.S. Translated from *Gazov. Prom-st.;* No. 9, 23-26(1975). 12p. Dep. NTIS $3.50.

Solid surfactant rods at fields with a low formation pressure and with elevated mineralization of the waters rapidly lose their initial efficacy. On the basis of the example of wells of the Takhta-Kugul'tinsk field there is shown the possibility and necessity of using aqueous surfactant solutions on low-yield gas-bearing areas. Using aqueous surfactant solutions improves working conditions, is economically more profitable, and is convenient in practice. The surfactant must be selected for each specific field, taking into account the temperature, pressure, and mineralization of the waters. Aqueous surfactant solutions may be used for well utilization, and for clearing out the face zone and the borehole after major overhauls. At fields with a small number of operating wells, automatic devices should be used for delivering aqueous surfactant solutions to the face.

24043 (SAND—76-9084) **Model calculations of the potential gradients used in massive hydraulic fracture mapping and characterization.** Bartel, L.C. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1976. Contract E(29-1)-789. 27p. (CONF-761029—1). Dep. NTIS $4.00.

From Society of Exploration Geophysicists conference; Houston, Texas, United States of America (USA) (24 Oct 1976).

In order to efficiently use massive hydraulic fractures to stimulate natural gas production in tight formations, knowledge of the extent and direction of fractures is essential. Sandia Laboratories is involved in the development and evaluation of an electrical technique for the mapping of massive hydraulic fractures. The technique under consideration is essentially a dynamic "misse-a-la-masse" method, which is referred to as the direct excitation electrical potential (DEEP) technique. The method makes use of the changes in electrical potentials at the surface of the earth produced by changes in the current electrode geometry where the electrode consists of the fracture well casing plus the associated conducting fracture fluid. To aid in the interpretation of the field data, a mathematical modeling effort was undertaken. The model calculations utilize a Green's function approach where the voltage distributions along the well casings and fracture fluid are taken into account. For modeling the potential gradients as a result of the fracture, the Green's function approach, with some simplifying assumptions, results in a closed form solution. The model calculations are presented along with a parametric study for optimizing the placement of potential electrodes as well as interpretation of field data. The calculated results have been compared to some field data which show that the direction of the fracture can be determined. It is anticipated that with close correlation of the model calculations and the field data, the extent of the fracture can also be determined.

24044 (UCID—17358) **Environmental assessment report: joint ERDA/GPE massive hydraulic fracturing experiment, Natural Buttes Unit, Uintah Co., Utah.** Tonnessen, K.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Jan 1977. Contract W-7405-ENG-48. 44p. Dep. NTIS $4.00.

This environmental assessment was prepared as a negative declaration regarding the environmental impacts associated with the joint Gas Producing Enterprises (GPE) and ERDA project to stimulate six natural gas wells by massive hydraulic fracturing in the Uinta Basin of Utah. The results of this program could prove

valuable in the exploitation of those potentially recoverable gas reserves in low permeability reservoirs as identified in the National Gas Survey by the Federal Power Commission. This assessment was prepared in accordance with Title 10, Part II of the Code of Federal Regulations for the implementation of the NEPA.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 24033, 24923, 24924

COMBUSTION

REFER ALSO TO CITATION(S) 23986, 24933

OIL SHALES AND TAR SANDS

RESERVES AND EXPLORATION

REFER ALSO TO CITATION(S) 23964

SITE GEOLOGY

REFER ALSO TO CITATION(S) 24032

DRILLING, FRACTURING, AND MINING

REFER ALSO TO CITATION(S) 24001

24045 (CONF-760237—, pp 43-62) **Creation of high fluid conductivity in an oil shale by injection of explosives.** Dockter, L. (Laramie Energy Research Center, WY). 1976.

From Symposium on stimulation of low permeability reservoirs; Golden, Colorado, United States of America (USA) (16 Feb 1976).

In Symposium on stimulation of low permeability reservoirs.

The modified in situ and true in situ methods for introducing permeability into oil shale formations for oil recovery are described briefly. The true in situ field work conducted at a site in SW Wyoming between Rock Springs and Green River is summarized. A fracturing program just completed at Rock Springs site 9 is discussed in detail. (5 tables, 6 fig.) (DLC)

24046 (SAND—75-0127) **Initial feasibility investigation of a hot gas-mechanical excavator for oil shale application.** Bauder, D.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). Mar 1975. Contract E(29-1)-789. 27p. Dep. NTIS $4.00.

A tool employing the combination of mechanical action and flow of hot gas has been proposed as an excavation device for oil shale. Small scale experiments with a high velocity, hot gas jet have determined relationships between excavation rate, gas temperature, gas pressure and shale grade. the energy input required was unacceptably high for the amount of shale removed. Improvements appear to be possible but a complete assessment of the potential of this excavation technique depends upon the acquisition of a more thorough understanding of the physical mechanism involved in the removal of shale.

OIL PRODUCTION, RECOVERY, AND REFINING

REFER ALSO TO CITATION(S) 24045

IN SITU METHODS, TRUE AND MODIFIED

REFER ALSO TO CITATION(S) 24010

24047 (CONF-750306—4) **Experimental approach to in situ oil recovery from tar sands.** Marchant, L.C.; Land, C.S.; Cupps, C.Q. (Energy Research and Development Administration, Laramie, Wyo. (USA). Laramie Energy Research Center). 1975. 31p. Dep. NTIS $4.00.

From 15. annual ASME symposium; Albuquerque, New Mexico, USA (6 Mar 1975).

Recovery of oil from domestic tar sands is being investigated for this purpose, and is part of the Laramie Energy Research Center's research program on unconventional energy resources. Results of laboratory experiments are discussed which indicate applicability of the reverse combustion process for in situ oil recovery from tar sands. Some characteristics of Utah tar sands as determined from core analysis are described. The design is described for a field experiment to evaluate application of reverse combustion for in situ oil recovery from tar sand in the Northwest Asphalt Ridge deposit in Utah.

24048 **Bitumen recovery from oil sands, using solvents in conjunction with steam.** Farouq Ali, S.M. (Pennsylvania State Univ., University Park); Abad, B. *J. Can. Pet. Technol.;* **15**: No. 3, 80-90(1976).

Results of an experimental investigation of bitumen recovery from Athabasca oil sand, using solvents in conjunction with steam, are discussed. Most of the runs were carried out in a vertical tar sand pack, with restricted fluid entry near the bottom of the pack, simulating conduction-convection heating with gravity flow. A few runs were conducted in a large three-dimensional model of a five-spot configuration. The synthetic crude manufactured by Great Canadian Oil Sands Ltd. was the principal solvent used. A few runs employed naphtha and the "Mobil Solvent." Actual Athabasca oil sand was used to pack the models, which did not permit scaling. It was found that bitumen recovery is determined by the type of the solvent, the volume used, and the solvent placement. For example, when the solvent was injected into the producing well, followed by steam injection into the injection well, the recovery was much higher than when both solvent and steam were injected into the same well. The water-bitumen ratio was higher in this latter case than in the previous injection scheme. The bitumen recovery tended to be higher when using naphtha, however, breakthrough occurred rapidly in this case. Also, naphtha caused asphaltene precipitation in several instances. The GCOS synthetic crude did not have these problems, and yielded higher bitumen-solvent ratios. The Mobil solvent matched the performance of the other two solvents, in different respects.

PURIFICATION

REFER ALSO TO CITATION(S) 23895

WASTE RESEARCH AND MANAGEMENT

REFER ALSO TO CITATION(S) 23950

FISSION FUELS

EXPLORATION

REFER ALSO TO CITATION(S) 25253

24049 (GJBX—2(77)) **Survey of lands held for uranium exploration, development and production in fourteen western states in the six month period ending June 30, 1976.** (Bendix Field Engineering Corp., Grand Junction, Colo. (USA)). 1976. Contract E(05-1)-1664. 24p. Dep. NTIS $3.50.

Tabulated data are presented to show the land distribution by ownership, distribution by states, distribution by land category, acres held by uranium industry, and land control by county and state. The states surveyed are Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming. (JSR)

24050 (GJBX—6(77)) **Hydrogeochemical and stream sediment reconnaissance: eastern United States. Savannah River Laboratory quarterly report, October—December 1976.** (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1976. Contract E(07-2)-1. 61p. (DPST—76-138-4). Dep. NTIS $4.50.

Contracts were issued for collection of approximately 22,500 ground water samples. Final quality assurance evaluation of sampling subcontractor performance was completed. Orientation sampling was completed in the Sussex County, New Jersey, area. Thorium and hafnium analyses were shown to be very important in interpretation of uranium distribution in sediments from the Kings Mountain, North Carolina, area. A 15-month study of seasonal variability in Oconee, South Carolina, and Brush Creek, North Carolina, showed no effects outside the range of normal sampling and analytical uncertainty. Concentration of dissolved ions on specially prepared ion exchange resin was studied. Total sampling and analytical error was less than 25 percent for uranium concentrations <100 parts per trillion (pptr). Greater than 90 percent recovery was observed for the 17 elements analyzed. Routine preparation of sediment samples was begun by one subcontractor at a rate of 1500 samples per month. Procedures were developed and tested for 24-hour daily automated operation of the NAA facility, and simulated malfunction tests were completed. Recommended elemental values

were established for sediment sample SRL-2, which will be used as a routine quality assurance standard. A contract was issued for the preparation and analysis of 1950 sediment samples and standards using reading emission spectroscopy. The ARCHIVE module of the Sample Inventory and Control System (SICS) was completed; programming to write sample accounting reports is in progress. The digitizer for automatically calculating sample coordinates was interfaced with the SRL-NURE Data Management System (NDMS). Routine use of the digitizer was begun. Thirteen new scrub parameters were added to the INPUT module of NDMS. Full-size symbol plot map overlays (for 1° x 2° sheets) have been produced from computer-generated microfilm. Alternative output options are being evaluated.

24051 (GJBX—10(77)) **Hydrogeochemical and stream-sediment survey of the National Uranium Resource Evaluation (NURE) program: western United States. Quarterly progress report, July—September 1976.** (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1976. Contract W-7405-ENG-48. 47p. (UCID—16911-76-3). Dep. NTIS $4.00.

Sample site selection and planning were initiated for a reconnaissance sampling project covering 14,000 square miles in western Utah. Reconnaissance sampling contracts were placed for the Humboldt River Basin and six basins in the Lovelock and Winnemucca quadrangles in northern Nevada. Planning was completed for two orientation studies in northeastern Washington. A technical paper, "Dispersion of Uranium and Selected Trace Elements in Playa Basins," was presented at the 25th International Geological Congress in Sydney, Australia, August 15-25, 1976. Installation of the high-throughput instrumental neutron-activation analysis system and a new delayed-neutron counter will be completed in December, 1976. An arc source and 22 direct-reading channels were added to the emission spectrometer for sediment analyses. The Phase II computer system was purchased with FY 1976T capital equipment funds. This system will provide on-line data reduction for several analytical systems and will perform all data-base-management tasks. A computer-readable magnetic tape of the data in the Walker River Basin Pilot Study report was sent to Oak Ridge National Laboratory for entry into the NURE national data base. Data reports for five orientation studies were open-filed in this quarter.

24052 (SAND—76-9100) **Pulsed neutron uranium borehole logging with prompt fission neutrons.** Bivens, H.M.; Smith, G.W.; Jensen, D.H. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1976. Contract E(29-1)-789. 6p. (CONF-761059—12). Dep. NTIS $3.50.

From 4. annual conference on the use of small accelerators; Denton, Texas, United States of America (USA) (25 Oct 1976).

The gross count natural gamma log normally used for uranium borehole logging is seriously affected by disequilibrium. Methods for the direct measurement of uranium, such as neutron logging, which are not affected by disequilibrium have been the object of considerable effort in recent years. This paper describes a logging system for uranium which uses a small accelerator to generate pulses of 14 MeV neutrons to detect and assay uranium by the measurement of prompt fission neutrons in the epithermal energy range. After an initial feasibility study, a prototype logging probe was built for field evaluation which began in January 1976. Physical and operational characteristics of the prototype probe, the neutron tube-transformer assembly, and the neutron tube are described. In logging operations, only the epithermal prompt fission neutrons detected between 250 microseconds to 2500 microseconds following the excitation neutron pulse are counted. Comparison of corrected neutron logs with the conventional gross count natural gamma logs and the chemical assays of cores from boreholes are shown. The results obtained with this neutron probe clearly demonstrate its advantages over the gross count natural gamma log, although at this time the accuracy of the neutron log assay is not satisfactory under some conditions. The necessary correction factors for various borehole and formation parameters are being determined and, when applied, should improve the assay accuracy.

24053 Uranium. A CEDA study. Sydney, Australia; CEDA (Apr 1976). 32p.

CEDA energy project position paper no.4; Price $A5.00.

This report discusses the exploration, mining and processing of uranium ores and estimates are given of both Australian and overseas resources. Market factors, industry ownership, government participation and investment are also discussed. A summary of the conclusions and recommendations of the CEDA group are presented.

24054 Solid state track detectors help search for uranium. Iyer, R.H. (Bhabha Atomic Research Centre, Bombay (India). Radiochemistry Div.); Rao, V.V. (Department of Atomic Energy, Hyderabad (India). Atomic Minerals Div.). *Nucl. India;* **15**: No. 1, 1,3,6,8(Sep 1976).

A simple track detector system for radon mapping required in uranium exploration has been developed at the Bhabha Atomic Research Centre, Bombay. In the first arrangement, the detector is suspended vertically at the axial position inside a hole in the soil under survey. In the second arrangement, the detector is fixed at the bottom of a small tumbler which is buried in an inverted position in the soil. The system in the second arrangement has been designated as DTS. Once implanted at different locations, the detectors are retrieved after a few weeks for radon mapping. The process has been termed as BARC-TEFUREX (Technique for Uranium Exploration). The system is useful in localised field studies as well as for detecting ground radon anomalies over large areas.

MINING

REFER ALSO TO CITATION(S) 24053

24055 Uranium mining and its role in supplying the FRG with nuclear fuels. Kegel, K.E. *Metall;* **30**: No. 10, 939-942(Oct 1976). (In German).

9 figs.

After the description of the different mining methods in open pit and underground mines, peculiarities of uranium mining are discussed. Various phases of uranium ore beneficiation and leaching methods are described. This is followed by a review of the development of uranium demand in the past and future, the supply of the uranium requirements in the Federal Republic of Germany and the activities of German uranium companies.

FEED PROCESSING

REFER ALSO TO CITATION(S) 24053

24056 Matrix consisting of cultivable mutants of unicellular green algae and method of uranium production using this matrix. Heide, E.A.; Paschke, M.; Wagener, K.; Wald, M. (to Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). German(FRG) Patent 2,345,430/A/. 17 Apr 1975. 5p. (In German).

For uranium production from seawater, a matrix consisting of a cultivable mutant of unicellular green algae is described. The algae are uranium-resistant and are able to take up uranium dissolved in seawater. Unicellular green algae are irradiated with X-rays, then put on culture media with high uranium contents and left there until they form a colony. The matrix is then put into a filter cage whose sieve walls are permeable to seawater but not to the mutants. The filter cage is placed in the sea in such a way that the tidal flows pass through it.

24057 Milling of uranium ores. Geier, H. *Bergbau;* **27**: No. 10, 396-399(Oct 1976). (In German).

2 figs.; 1 tab.; 7 refs.

A short survey of the most important uranium minerals is followed by a description of the principles of uranium ore milling and its treatment with acid and alkaline solutions. The subjects process technique development, investment costs, and production costs are also briefly mentioned.

ENRICHMENT

REFER ALSO TO CITATION(S) 24128

24058 (CONF-760696—1) **ERDA's view on new enrichment capacity.** O'Connor, E.F. (Energy Research and Development Administration, Washington, D.C. (USA)). 1976. 11p. Dep. NTIS $3.50.

From International conference on uranium enrichment; New York, New York, United States of America (USA) (30 Jun 1976).

GASEOUS DIFFUSION

24059 Taperization of step cascade for uranium enrichment by gaseous diffusion process. Higashi, K.; Miyamoto, Y. (Kyoto Univ. (Japan). Faculty of Engineering). *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 1, 30-34(Jan 1976).

An analysis of the effect of flow (or pressure) tapering on the productivity of step cascades, with account taken of the relations existing between the interstage flow rates, pressure levels and stage separation factors, revealed that productivity and separative work could increase by about 4% in a typical 3-size gaseous diffusion plant. A considerable gain could be expected by applying the tapering to sections comprising about 30 stages, into which each step would be divided. Further, an examination is made of the extent of reduction that can be expected of the mixing loss through flow tapering.

LASER EXCITATION

REFER ALSO TO CITATION(S) 24132

24060 Economics of uranium enrichment by laser isotope separation process. Ozaki, N.; Yamada, K. (Hitachi Ltd., Kawasaki, Kanagawa (Japan). Atomic Energy Research Lab.); Yamamoto, M.; Tomiyama, S.; Ueyanagi, K. *Nippon Genshiryoku Gakkaishi;* **18**: No. 3, 150-157(Mar 1976). (In Japanese).

The probability of the selective two-step photo-ionization of ^{235}U atom by laser and ultraviolet radiations is estimated from the rate equations for uranium atom with two isotopes with three levels. The population of ^{235}U ions is obtained by linearizing the rate equations. We have calculated the ion production rates for three cases in which the laser and ultraviolet powers are changed while the atom density is kept constant. The power consumption and the capital investment required for the large-scale laser enrichment plant conceptionally designed based upon the above results, and consequently the unit cost of separative work are estimated. It is clarified in this study that the laser isotope separation process is competitive to the conventional gaseous diffusion and gas centrifugal methods.

FUELS PRODUCTION AND PROPERTIES

REFER ALSO TO CITATION(S) 24350, 25067, 25072, 25075, 25242

24061 (ORNL/TM—5152) **Fluidized bed deposition and evaluation of silicon carbide coatings on microspheres.** Federer, J.I. (Oak Ridge National Lab., Tenn. (USA)). Jan 1977. Contract W-7405-ENG-26. 58p. Dep. NTIS $4.50.

The fuel element for the HTGR is an array of closely packed fuel microspheres in a carbonaceous matrix. A coating of dense silicon carbide (SiC), along with pyrocarbon layers, is deposited on the fueled microspheres to serve as a barrier against diffusion of fission products. The microspheres are coated with silicon carbide in a fluidized bed by reaction of methyltrichlorosilane (CH_3SiCl_3 or MTS) and hydrogen at elevated temperatures. The principal variables of coating temperature and reactant gas composition (H_2/MTS ratio) have been correlated with coating rate, morphology, stoichiometry, microstructure, and density. The optimum temperature for depositing highly dense coatings is in the range 1475 to 1675°C. Lower temperatures result in silicon-rich deposits, while higher temperatures may cause unacceptable porosity. The optimum H_2/MTS ratio for highly dense coatings is 20 or more (approximately 5% MTS or less). The amount of grown-in porosity increases as the H_2/MTS ratio decreases below 20. The requirement that the H_2/MTS ratio be about 20 or more imposes a practical restraint on coating rate, since increasing the total flow rate would eventually expel microspheres from the coating tube. Evaluation of stoichiometry, morphology, and microstructure support the above mentioned optimum conditions of temperature and reactant gas composition. 18 figures, 3 tables.

24062 (RFP—2552) **Light water reactor fuel recycle program. Plutonium nitrate-to-oxide conversion project initial report, April 1976.** Erickson, E.D. (Atomics International Div., Golden, Colo. (USA). Rocky Flats Plant). 17 Jan 1977. Contract EY-76-C-04-3533. 5p. Dep. NTIS $3.50.

Rocky Flats Plant has received a contract from the Savannah River Operations Office of ERDA to critically analyze and evaluate existing technology for converting plutonium nitrate to plutonium oxide, and to recommend improved flow sheets and equipment for this process. Information will be provided to produce a conceptual design and cost study for a plutonium nitrate conversion facility usable in a LWR fuel recycle plant. A program plan has been written detailing the technical approach, the expected results, and personnel utilization. During the fourth quarter of FY 1976 the basis for comparison and selection of existing conversion processes will be defined, a literature search will be made for conversion processes, and contacts will be made with ERDA contractors and those in private industry who have knowledge of conversion processes.

24063 (U,Zr)N alloy with increased thermal stability. Potter, R.A.; Scott, J.L. (to Energy Research and Development Administration). German(FRG) Patent 2,532,739/A/. 12 Feb 1976. 7p. (In German).

1 tab. Available from Dt. Patentamt, Muenchen (FRG).

The ceramic fuel (Usub(x) Zrsub(y))N is claimed in which the uranium nitride phase contains a solution of zirconium nitride which is to prevent the uranium nitride form dissociating at higher working temperatures. Zirconium is present in quantities of 3 to 10 mol %. Above 1,600°C this alloy exhibits a better stability than pure UN. One obtains the fuel by converting an alloy made of uranium metal with 2 to 10 wt % zirconium metal into a nitride powder and by sintering this to a compact solid which is suitable for use in high temperature nuclear reactors. For use in other types of reactors (e.g. breeders) one can add Pu or Th to the alloy.

24064 Irradiation behaviour of experimental fuel particles containing chemically vapour deposited zirconium carbide coatings. Reynolds, G.H. (Tapco International, Houston, Texas, (USA)); Kaae, J.L. (General Atomic Co., San Diego, Calif. (USA)); Janvier, J.C.; Morlevat, J.P. (Commissariat a l'Energie Atomique, Centre d'Etudes Nucleaires de Grenoble, Grenoble, France). *J. Nucl. Mater.;* **62**: No. 1, 9-16(Oct 1976).

Four experimental fuel particle designs, utilizing zirconium carbide coatings in combination with porous and dense pyrocarbon coatings, were tested under high-temperature irradiation. As a fission-product corrosion test for the zirconium carbide, two particle designs employed carbide coatings applied directly over either UC_2 or (8Th, 1U)O_2 fuel kernels. The other two designs utilized zirconium carbide outside of porous pyrocarbon coatings but without the conventional inner dense pyrocarbon coating on either UC_2 or (8Th, 1U)O_2 fuel kernels. The particles were irradiated at 1200°C to a fast-neutron fluence of 5×10^{21} n/cm^2 (E<0.18 MeV) and fractional burnups of the initial metal atoms of 0.7 and 0.08 for the UC_2 and (8Th, 1U)O_2 kernels, respectively. Stereoscopic, metallographic and electron-beam microprobe examination of the irradiated particles showed that the zirconium carbide possesses exceptional resistance to chemical attack by fission products and good mechanical stability under irradiation.

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 24087, 24089, 24108, 24126, 24127, 25121, 25242, 25589

24065 (BNWL—2115) **High temperature gas-cooled reactor criticality research program.** Bierman, S.R.; Clayton, E.D. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jun 1976. Contract E(45-1)-1830. 25p. Dep. NTIS $3.50.

Objective is to define the nuclear criticality research program needed in support of the HTGR fuel cycle outside reactors. An experimental plan and supportive calculational efforts are presented. Currently, some data on well-moderated ^{235}U and ^{233}U exist which are applicable to thorium—uranium fuel mixtures. However, experimental data are needed for undermoderated ^{235}U and ^{233}U systems. Data are needed also on ^{235}U and ^{233}U containing soluble neutron poisons and in the presence of fixed neutron poisons. For future fuels and processes in which thorium and uranium cannot be separated, there would be a large economic incentive for including the thorium in the criticality considerations. The research program presented covers all aspects of the experiments needed to provide data in the above areas. (DLC)

24066 (DPST-LWR—76-2-3) **Light water reactor fuel recycle. Composite quarterly report, July—September 1976.** (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1976. Contract E(07-2)-1. 122p. Dep. NTIS $7.75.

This report summarizes studies by participating ERDA sites to produce information needed to close the back end of the commercial LWR fuel cycle. These studies are directed primarily at reprocessing and recycle of uranium and plutonium from spent LWR fuel. Processing areas under study in this program are head-end treatment of the spent fuel, treatment of off-gas from various parts of the reprocessing system, recovery and purification of uranium and plutonium by the Purex solvent-extraction process, mixed-oxide fuel fabrication, and waste management (evaporation storage). Additional information is being provided by economic and environmental studies of the LWR fuel cycle, and by general support activities such as corrosion and shielding studies and development of improved on-line process-control methods. (DLC)

24067 (ICP—1101) **LWR fuel reprocessing and recycle progress report, April 1—June 30, 1976.** Slansky, C.M.; Dickey, B.R.; Musgrave, B.C.; Rohde, K.L. (Idaho National Engineering Lab., Idaho Falls (USA)). Nov 1976. Contract EY-76-C-07-1540. 27p. Dep. NTIS $4.00.

The presence of water or nitrogen dioxide in an untreated off-gas stream will detrimentally affect the performance of a silver-exchanged zeolite adsorbent. The waste management program is being performed (1) to determine the behavior of LWR liquid wastes during evaporation and storage with regard to solids production, fouling tendencies, and off-gas behavior, and (2) to evaluate materials of construction for process evaporators and waste tanks. Simulated high-level liquid waste (HLLW) solutions were prepared by combining stock solutions to closely approximate the components in actual process waste solutions. Vapor-liquid equilibrium compositions of nitric acid were measured to determine the effect of components in HLLW on the volatilization of HNO_3. Laboratory evaporations were conducted to determine the physical and chemical properties of HLLW solutions during evaporation. Data are reported for boiling point rise, density, and undissolved solids at varying degrees of concentration. A pilot unit thermosyphon evaporator was designed on the basis of conditions proposed for the HLLW waste evaporator at Barnwell Nuclear Fuel Plant (BNFP) for LWR fuels. The long-term physical characteristics of solids formed in the

HLLW solutions are being investigated during storage without agitation at 35°. Laboratory corrosion tests are being initiated to determine the effects of waste compositions of materials of construction in evaporators and storage tanks. Materials which have been selected for testing in the reboiler section of the pilot plant evaporator are types 304L, 309S, and 310S stainless steels, titanium, Nitronic-50, Carpenter 329, Sandvik 2 RE 10, and Sandvik 2 RE 69 ELC.

24068 (ICP—1108) **LWR fuel reprocessing and recycle progress report for July 1—September 30, 1976.** Slansky, C.M.; Dickey, B.R.; Muskgrave, B.C.; Rohde, K.L. (Idaho National Engineering Lab., Idaho Falls (USA)). Dec 1976. Contract EY-76-C-07-1540. 25p. Dep. NTIS $3.50.

LWR Off-Gas Treatment: A reference facility has been described in a draft report. A survey of technical literature for immobilization of $^{14}CO_2$ was completed. Waste Management: Laboratory evaporations were continued using simulated HLLW solutions representing three fuel cycle processes. Total solids content at various degrees of evaporation are presented together with boiling point rises and slurry densities. Substitution of less costly materials for Rh, Pd, and Tc did not affect the physical properties of the slurries or the quantity of solids formed. The effect of adding nuclear poisons (gadolinium, boron, or cadmium) on physical properties of HLLW and on solids formation is reported. Solids formed in all HLLW solutions contained major amounts of Zr and Mo. The design of the small-scale thermosyphon evaporator and the reboiler tube test specimen are presented. Evaporated HLLW slurries stored for two months at 35°C have not produced significantly more solids. Laboratory corrosion data showed excessive corrosion occurred in HLLW containing high iron concentrations and 7 M HNO_3, apparently due to Cr formed by stainless steel corrosion. Iodine-129 Adsorbent and Storage Development: Silver-exchanged zeolite (AgX) and mordenite (AgZ) were loaded with and stripped of elemental iodine for evaluation for recycle behavior. After five cycles, the AgZ showed no decrease in loading (approximately 440 mg/g); the AgX loading dropped about 50 percent from its initial value of 320 mg/g. (DLC)

24069 (RFP-Trans—206) **5.4 Recovery of plutonium from scrap and wastes. 5.5 Recovery of neptunium-237, plutonium-238, and plutonium-242.** Kuhn, K.D.; Scheffler, K.; Koch, G. [nd]. Translated from pp 279-315 of Transurane A1. 61p. Dep. NTIS $4.50.

Two chapters are included. The first, entitled Recovery of Pu from Scrap and Wastes, includes discussion under the following section headings: waste types; sequence of recovery; Pu preconcentration by washing or burning; dissolution of materials containing Pu; Pu prepurification; and, final purification of Pu. The second chapter is entitled Recovery of Neptunium-237, Plutonium-238, and Plutonium-242. Discussion is presented under the following section headings: recovery of Np-237: process chemistry of Np, recovery of Np in chemical reprocessing of natural and slightly enriched uranium fuels (at Hanford Purex plant, Hanford redox plant, Savannah River plant, French plants in Marcoule and Cap de La Hague, Windscale reprocessing plant, Karlsruhe reprocessing plant, Eurochemic plant, and reprocessing plants of the USSR and India), recovery of Np in chemical reprocessing of highly enriched fuels (at Savannah River plant and Idaho chemical processing plant), separation of Np from residues of uranium fluorination, and, development of other processes; recovery of plutonium-238, anion exchange procedures for Pu-238 separation (Savannah River, Hanford, and Harwell processes), liquid-liquid extraction for Pu-238 separation (amine extraction at Fontenay-aux-roses, recovery of low-assay Pu-238 at Savannah River plant, and, proposed continuous Pu-238 production at Harwell), Pu-238 from irradiated Am-241; and, separation of Pu-242 (at Savannah River, Oak Ridge, Fontenay-aux-roses, and Karlsruhe). Extensive bibliographies are included for each chapter. (JGB)

24070 (RFP-Trans—218) **Reprocessing and waste-treatment project of the GFK.** Kroebel, R. Translated from *KFK Nachr.;* **6**: No. 4, 4-8(1974). 9p. Dep. NTIS $3.50.

The international capabilities for reprocessing LWR spent fuels and the rationale for reprocessing these fuels are summarized as an introduction to a brief description of the R and D project of the Gesellschaft fuer kernforschung. This project is designed to meet the needs of the German Federal Republic in the handling of LWR fuels and the treatment of radioactive wastes. The aims of the project are tabulated and the specific goals for 1975 discussed. (JSR)

24071 (RFP-Trans—219) **Design of a large reprocessing plant.** Issel, W.; Knoch, W. Translated from *Atomwirtsch., Atomtech.;* **20**: No. 7, 339-342(1975). 7p. Dep. NTIS $3.50.

The starting point of the design study being undertaken by KEWA for a reprocessing plant to be erected in West Germany is a series of considerations and data. Those will be presented here, but cannot anticipate the results of the design study. The considerations concern the plant size, reprocessing methods, safety, deadlines, and costs. A nominal capacity of 1400 tons/yr is assumed for the plant, and the required pit capacity for storage of irradiated fuel assemblies is estimated as 3000 tons U. The design calculation assumes a target burnup of 40,000 MWd/tU and a minimum cooling time of 365 days at the beginning of reprocessing.

24072 (ORNL-tr—4232) **Photometric determination of nitrite in PUREX-process-solutions.** Knittel, G.; Ertel, D.; Dressler, P. (Kernforschungszentrum Karlsruhe (Germany, F.R.)). Jun 1976. Translation by S.D. Blalock Jr. of KFK—2263. 10p. Dep. NTIS $3.50.

The applicability of the photometric nitrite determination with α-naphtylamine and sulfamic acid for the analysis of PUREX process aqueous and organic solutions was tested. The upper limit of the concentration ratio of uranium and plutonium to nitrite was found to be 150 and 80 respectively, i.e., 20 μg NO^-/sub 2/ can be determined in the presence of 15 mg U(VI) or 8 mg Pu(IV). The calibration curve is linear up to 30 μg NO^-Z/25 ml and the sensitivity is 1 X 10^{-6} M NO^-Z. The content of nitric acid during the absorbance measurement must not exceed 1.5 mmol HNO_3/25 ml. If NO^-Z is to be determined in an organic solution, a yield of approximately 99 percent NO^-Z is attained in a single reextraction. The method is sufficiently accurate and suitable for a routine nitrite determination.

24073 **Separation of fission rare gases from off-gases in nuclear facilities by low temperature distillation.** Glatthaar, R. (Linde A.G., Hoellriegelskreuth/Muenchen (Germany, F.R.). Werksgruppe Tieftemperatur und Verfahrenstechnik). *Kerntechnik;* **18**: No. 10, 431-434(Oct 1976). (In German).

3 figs.; 5 refs.

In view of its ^{85}Kr content, the Kr contained in the off-gas generated in a fuel reprocessing plant must be removed in order to reduce the activity carried by the gas released into the atmosphere. This can be achieved by low temperature distillation. The Xe which is also contained in the off-gas may be considered inactive. If this Xe is removed by adsorption before the distillation step, the part of the facility which carries highly concentrated active media can be designed relatively simply.

24074 **Reprocessing of nuclear fuels.** Bebbington, W.P. *Sci. Am.;* **235**: No. 6, 30-41(Dec 1976).

This survey of nuclear fuel reprocessing begins with a description of the composition of spent fuels and of the treatment and storage of radioactive wastes. A discussion of technology and engineering design for reprocessing plants is accompanied by schematic diagrams of equipment and processes; and an account is given of attempts to build and operate the plants. Safety considerations, environmental aspects, and public opinion of the various methods of waste treatment are discussed. (DDA)

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 24729

24075 (UCRL—78370) **Seismic effects on modularized spent fuel storage facilities.** Dong, R.G.; Tokarz, F.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1976. Contract W-7405-ENG-48. 9p. (CONF-770103—3). Dep. NTIS $3.50.

From 6. world earthquake conference; New Delhi, India (10 Jan 1977).

Large pools are being considered to provide additional storage capacity for spent fuel from nuclear power plants. Because of the large size, modularization of the pool into cells would enhance operational safety and convenience in terms of isolating trouble spots and performing localized clean-up. However, the effects of modularization on earthquake resistance were not clear. An investigation of these effects was made and the results are presented. The findings indicate that modularization may or may not be advantageous in terms of structural loads, depending on the pool configuration and installation. 5 fig.

24076 (GERHTR—147) **Ultimate storage of spent fuel elements from the AVR experimental nuclear power plant in the Asse Salt Mine.** Wolf, J. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Chemische Technologie). Feb 1975. Translation of Jul—1163. 161p. Dep. NTIS $6.75.

Work performed under United States—German High Temperature Reactor Research Exchange Program.

The present paper is intended to serve as the basis for the licensing procedures both in respect of the transport and storage techniques and also for the ultimate storage itself. In regard to the technique it will be shown on the basis of design drawings and calculations that the handling, transport and storage of the fuel elements can be safely carried out in accordance with the regulations in force. In regard to the ultimate storage itself, since no highly radioactive wastes with a long-lived actinide content have yet been stored, it will be necessary to show that an unacceptable contamination of the biosphere will be avoided even in the long term under all anticipated conditions. It will further be necessary to show by

calculations and suitable tests, in view of the radioactive gas and fissile material content, that no danger due to gas release from the fuel elements will arise during the operating life of the mine and that a nuclear criticality risk can be excluded for all time.

24077 Impact of nuclear fuel cycle centers on shipping special nuclear materials and wastes. Blomeke, J.O. (Oak Ridge National Lab., TN). pp 181-200 of In Civil and environmental engineering aspects of energy complexes. New York; American Society of Civil Engineers (1976).

From Engineering foundation conference; Henniker, NH ;USA: (3 Aug 1976).

Problems related to the shipments of radioactive materials among the various facilities that compose the nuclear fuel cycle are considered. The discussion in this paper is limited to a comparison of shipping requirements for the case of independently sited, dispersed fuel cycle facilities with that of a single, integrated fuel cycle facility. Fuel cycles for both U and Pu fuels are depicted schematically. It is concluded from this rather narrow study that the advantage due to an integrated fuel cycle appears to be of only marginal significance. (BLM)

24078 Judicial problems connected with transport and supervision permits. Johlige, H. (Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.)). pp 187-202 of In Viertes deutsches Atomrechts-Symposium. Referate und Diskussionsberichte. Cologne; Heymanns (1976). (In German)

From 4. German symposium on nuclear law; Goettingen, Germany, F.R. (26 May 1975).

With figs. and tabs.

The stipulations on the transport of radioactive materials in the draft of the new Radiation Protection Ordinance should be again discussed from various aspects. The aim of further law elaboration should be the uniformation of the transport regulations on the basis of the IAEA - Regulations for the Safe Transport of Radioactive Materials 1973 Revised Edition. Apart from that, directions for the control of transport of radioactive materials and accident information leaflets should be elaborated.

24079 International stipulation concerning the transport of radioactive materials. Ost, W. pp 203-224 of In Viertes deutsches Atomrechtes-Symposium. Referate und Diskussionsberichte. Cologne; Heymanns (1976). (In German)

From 4. German symposium on nuclear law; Goettingen, Germany, F.R. (26 May 1975).

With tabs. and refs.

From the purpose sect. 1 no. 4 AtG results the obligation to be open for everything which happens in atomic law outside the Federal Republic of Germany. A detailed survey on the state of international legal coordination as far as the Federal Republic of Germany is concerned is provided.

24080 Storage and processing system for fissile materials. Bubowskii, B.G.; Bogatyrew, W.K.; Wladykow, G.M.; Swiridenko, W.J. German(FRG) Patent 2,239,050/B/. 4 Mar 1976. 6p. (In German).

5 figs.

The invention concerns the construction of a radiation protection wall by which the reflection of neutrons in a container arranged in the vicinity of the wall is reduced. The radiation protection wall has a coating of neutron-retarding material on top of which there is a layer of neutron absorbing material, the former having a surface structured with regular projections and recesses spaced at 1/8 to 3 neutron ranges. The recesses may be filled with porous material or take up neutron radiation detectors. Other construction features are described.

24081 (MLM—2394(TR)) **Procedure and mechanism for transporting highly-active cylindrical solid wastes.** Weber, M.; Flinzberger, V. 18 Jan 1977. Translation of German Patent 112,320. 17p. Dep. NTIS $3.50.

The invention is a procedure and mechanism for the transportation of various highly-active cylindrical solid wastes that are first inserted one after the other into a horizontally rotating magazine and then, after transportation, taken out in a bin at the end and transported below ground. Through this invention, the task is solved in the following manner. The solid radioactive waste, prepared in the form of a glass cylinder, is welded into a sheet steel cylinder, onto which is mounted an abutment. The cylinders are then inserted into the hydraulic, horizontally rotating magazine of the mechanism by means of a special grab which takes hold of the abutment--its companion piece--and transports it to the unloading bin. The unloading of the transport container is done above ground by means of an upright cover container with a closeable bottom aperture guided by a centering rim. The waste matter is taken, piece by piece, out of the transport container with the special grab and placed in the cover container. The sliding door of the transport container and that of the cover container are opened and closed at the same time, and between them there is a form-locking closure. Only the cover container is transported underground into the tunnel conveyance system, placed on a special vehicle, and driven to one of the prepared deposit shafts in the deposit field. The waste matter is then lowered into the deposit shafts by means of grabs near the opened aperture at the bottom of the cover container.

MARKETING AND ECONOMICS

24082 New principles for nuclear energy. Nuclear power plants-only a link in the chain of the fuel cycle's technical capacities. *VDI (Ver. Dtsch. Ing.) Nachr.;* 30: No. 43, 7(Oct 1976). (In German).

A short survey is presented on the present situation of the uranium market. The export-import policies of the countries mining uranium, in particular those of the USA, could have an impeding effect on the nuclear energy programme.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 24068, 24077, 24081, 24119, 24122

24083 (BNWL—1921) **Appraisal of airborne radioactive effluent sampling systems: comprehensive analysis format and in-place sampler validation.** Schwendiman, L.C. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1976. Contract EY-76-C-06-1830. 43p. Dep. NTIS $4.00.

A comprehensive analysis format has been developed for installed radioactive gaseous effluent sampling systems. It provides the necessary questions which when accurately answered should permit a good analysis of the sampling system and provide documentation for sampler system description, mode of operation, etc. Feasibility was shown for the application of gases and particles in a "validation package" which will permit a good physical demonstration of sampling systems. Preformed particles with gravimetric methods for measurement appear to have certain advantages, but further study, using available equipment, should be undertaken. Selected systems would be demonstrated under simulated and actual sampling situations. Detailed procedures would be developed.

24084 Management of radioactive wastes. Lennemann, W.L.; Parker, H.E.; West, P.J. *Ann. Nucl. Energy;* 3: No. 5;6, 285-295(1976).

From European nuclear conference; Paris, France (Apr 1975).

There are several areas of current concern either bordering on or regarding radioactive waste management in the nuclear fuel cycle. These areas have local, regional and global aspects and require either immediate attention or preparation for future implications. Those areas requiring immediate attention are better management control over mill tailings, a shortage of irradiated fuel storage space, and decommissioning criteria. Fuel storage should be recognized as a viable alternative to reprocessing for at least the next decade and suitable storage space should be incorporated in nuclear reactor facilities. Regulatory bodies should establish decommissioning criteria which then should be taken into account during the planning and design of a nuclear facility. Areas indicating future implications are removal and confinement of gaseous radionuclides, particularly tritium and ^{85}K. There is now also some concern regarding ^{14}C which should be investigated. Resolving the high-level and alpha-bearing waste disposal question seems to be one of the most serious problems and highest priority objectives facing the nuclear industry today. Use of suitable geologic formations appears to be the only technology which will be available for the next several decades. The alternative is surface storage in engineered facilities which does not finally answer the question. Consequently, demonstrating the disposition of high-level and alpha-bearing wastes in suitable geologic formations should proceed without delay. International cooperation in the establishment and use of regional centers rather than having a proliferation of local facilities for fuel reprocessing should facilitate significantly the management of the resulting radioactive wastes. It would also reduce the hazards associated with having a large number of sources for radioactive releases.

24085 Radioactive waste management in the United Kingdom. Hill, J. (UKAEA). *Atom (London);* No. 240, 250-253(Oct 1976).

From International symposium on the management of wastes from the LWR fuel cycle; Denver, Colo., USA (11 Jul 1976).

An account is given of the history of nuclear reactor fuel processing at Windscale, UK. Reference is made to the internationally recognized recommendations of the International Commission on Radiological Protection (ICRP) as embodied in the Government paper 'The Control of Radioactive Wastes', and the way in which these recommendations can be applied to a practical program are set out as broad general principles of plant design. The main types of wastes are categorized, together with the way in which they are currently handled - these are gaseous wastes, low active solid waste,

high active solid waste, low active liquid waste, medium active liquid waste, and highly active liquid waste. With regard to the future it is not expected to make any immediate major changes, except that in the new reprocessing plant to be constructed at Windscale it is intended to make provision for ^{129}I removal. Research on effective Pu recovery techniques is under way. With regard to gaseous wastes it may become necessary to install equipment to remove highly active products from them. More research is required on geological formations and processes and on oceanic movements. Participation in a number of international programs is in progress with a view to finding the most suitable methods for ultimate disposal. The vitrification process is discussed. Answers to critics are considered.

WASTE PROCESSING

REFER ALSO TO CITATION(S) 24067, 24069, 24070, 24073, 24074

24086 (BNWL—2138) **Fluidized bed calcination experience with simulated commercial high-level nuclear waste.** Bjorklund, W.J. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Nov 1976. Contract E(45-1)-1830. 80p. Dep. NTIS $5.00.

Development and testing of a pilot-scale fluidized bed calciner (1-2 MTU/day) are described. Simulated high-level liquid waste compositions representing those most likely to be generated by commercial nuclear fuel reprocessors were calcined prior to conversion to borosilicate glass forms. A new, much improved operating technique, continuous inert-bed operation (CIB), is described. 38 figures, 16 tables.

24087 (ICP—1100) **Prediction of krypton and xenon recovery in a cryogenic distillation column operating at total reboil.** Bendixsen, C.L. (Idaho National Engineering Lab., Idaho Falls (USA)). Nov 1976. Contract EY-76-C-07-1540. 55p. Dep. NTIS $4.50.

Krypton and xenon produced during nuclear fission of uranium is recovered from off-gases released during nuclear fuel dissolution and are collected in a semi-continuous cryogenic distillation column. Steady state and unsteady state mathematical models are developed to predict the response of the multicomponent distillation column. Variations in feed concentrations, feed flowrate, and column pressure are studied via an iterative computer program to determine their effect on krypton recovery efficiency. 13 figures.

24088 (SAND—76-9307) **Sandia solidification process: a brief overview.** Schwoebel, R.L.; Johnstone, J.K. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1976. Contract E(29-1)-789. 8p. (CONF-770102—1). Dep. NTIS $3.50.

From Workshop on ceramic and glass radioactive waste forms; Germantown, Maryland, United States of America (USA) (4 Jan 1977).

The Sandia Solidification Process effectively removes virtually all cationic species from a reactor waste stream and can also remove selected isotopes for beneficial applications. Various separation and partitioning studies are currently in progress. Following a waste solidification application, the solid waste can be easily consolidated using hot-pressing techniques into an apparently stable but complex ceramic waste form. The entire process has been successfully demonstrated with fully radioactive reactor wastes. Characterization studies have shown the detailed structure of the final waste form and its thermal/chemical behavior to be complex. These results suggest that detailed characterization studies are necessary for any waste form and that extreme care must be taken when extrapolating data to long times. 6 fig.

24089 (RFP-Trans—217) **Twenty years of research in the processing of radioactive fuel and neutralization of radioactive waste at the Nuclear Research Institute (NRI).** Kyrs, M.; Malek, Z.; Vesely, V. Translated from *Jad. Energ.;* **21**: No. 5, 181-183(1975). 5p. Dep. NTIS $3.50.

A complete review of the activities of workers in the field of radiochemistry over the past twenty years is given. It is subdivided into problems of the aqueous methods, fluoride method, and problems encountered in processing radioactive waste.

24090 **Method of treatment of waste water from UF_6 hydrolysis.** Crossely, T.J. (to Westinghouse Electric Corp.). German(FRG) Patent 2,448,733/A/. 24 Apr 1975. 11p. (In German).

1 fig.

Waste water resulting from the production of UO_2 from UF_6 (via ammonium diuranate) contains ammonia, toxic fluorides and small amounts of uranium. The suggested process enables the complete repeated use of the water with the uranium so that no deposit is necessary. The fluorides in the waste water are precipitated out by adding a stoichiometric amount - or a slight excess - of an alkali earth metal compound, preferably $Ca(OH)_2$. The ammonia is distilled off from this suspension and fed back into the UF_6 system. By centrifuging the suspension free of ammonia one obtains a uranium-free fluoride and waste water which is now finally purified of all suspension particles and then of cations and where necessary anions via ion exchange beds. As this is used again in the UF_6 process, the slight traces of uranium do not matter.

24091 **Method and equipment for the disposal of radioactive waste.** Hanss, P. (to Elba-Werk Maschinen G.m.b.H. und Co.). German(FRG) Patent 2,421,142/A/. 13 Nov 1975. 11p. (In German).

1 fig.

An improvement of the method to dispose of radioactive wasters by embedding in a concrete mixture is proposed in which the residues of mixing and filling materials occuring hither to in the processing which necessitate a complicated purification expenditure, are avoided. It is suggested to introduce radioactive wastes, cement and additions directly into the transport container via a dosing device and to mix in this container using a depressable stirring apparatus. The details of the filling and mixing station are described.

24092 **Decontamination factor of an incinerator for radioactive solid wastes.** Machida, C. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment); Kodaira, N. *Nippon Genshiryoku Gakkaishi;* **17**: No. 12, 661-666(Dec 1975). (In Japanese).

An incinerator for the treatment of low-level radioactive solid wastes was installed in Tokai Research Establishment, JAERI, 1966. The incinerator was equipped with a scrubber, cyclone, electrostatic precipitator and HEPA filter. The retention factor (R.F.) of the furnace as well as the decontamination factors (D.F.) of each dust collector were measured using ^{32}P as a tracer under various conditions. It was found that the overall D.F. of the incinerator was improved by the increase of the temperature in the furnace, decrease of the off gas flowrate, increase of the charged voltage of the electrostatic precipitator and by the increase of the liquid gas ratio of the scrubber. The overall D.F. of the incinerator (including the R.F. in the furnace) on the standard operating conditions was 9.1×10^6.

24093 **Purification of low-active solutions from long-lived isotopes by means of natural sorbents.** Sultanov, A.S.; Radyuk, R.I.; Tashpulatov, D. *Radiokhimiya;* **18**: No. 4, 672-675(1976). (In Russian).

From 11. Mendeleev' congress on general and applied chemistry. Radiochemistry and nuclear technology section; Alma-Ata, USSR (22 Sep 1975).

Published in summary form only; for English translation see the journal Sov. Radiochem.

24094 **Continuous vitrification of concentrated solutions of fission products.** Jouan, A.; Sombret, C. *Ann. Nucl. Energy;* **3**: No. 5;6, 275-283(1976). (In French).

From European nuclear conference; Paris, France (Apr 1975).

Transformation of solutions of fission products to a vitrified solid for completely safe ultimate storage is being undertaken in France. The continuous vitrification process perfected by the CEA results in a considerable reduction in volume of the materials. The apparatus, which is a rotary calciner for the solution and a fusion furnace to vitrify the calcined product, is described. Results and comments on 7400 h of experiments on a prototype at Marcoule, are given. A new vitrification furnace which acts on the molten glass is also described. The satisfactory operation and reliability by the process has meant that the industrial development stage can begin with construction of a facility on the Marcoule site.

24095 **Vitreous matrices for the containment of high-level Purex Waste.** Mukerji, J.; Sanyal, A.S. *Ann. Nucl. Energy;* **3**: No. 5;6, 253-274(1976).

A study is presented of various vitreous matrices for the incorporation of Purex wastes generated in India. The melting behavior of the matrices, the long-term extraction of fission products by various attacking agents, and the physical and chemical properties of the matrices are given. The study has been made in such a way that the compositional diagrams presented should help in formulation of vitreous matrices for containment of Purex wastes of wide range of compositions. Both silicate and phosphate glasses have been studied and the factors affecting selection of glass composition for containment of nuclear waste have been discussed.

24096 **Material absorbing radioactive iodine and iodide, method of production, and application in the removal of radioactive iodine and radioactive iodides from an off-gas flow.** Goldsmith, J.M.; O'Hara, D.K.; Rivers, R.D.; Pasha, M.; Fowler, E.E. (to American Air Filter Co., Inc.). German(FRG) Patent 2,508,544/A/. 29 Jan 1976. 18p. (In German).

Suggested for the removal of radio-active iodine and organic iodides from the waste gas stream of a nuclear reactor is a ceramic material impregnated with silver nitrate or another metal nitrate, preferably SiO_2 aluminium oxide, whereby the ceramic material should have a surface factor between 5 and 250m^2/g. The amount of impregnating medium should be between 5 and 15 percent by weight. The data for temperatures and drying times for the production of the absorber are given.

24097 Process and device for making glass particles from radioactive waste suspensions or calcines. Heimerl, W.; Vornhusen, H. (to Gelsenberg A.G.). German(FRG) Patent 2,453,404/A/. 13 May 1976. 9p. (In German).

3 figs. Available from Dt. Patentamt, Muenchen (FRG).

For safe storage, radioactive substances may be embedded in glass particles. It is proposed to do this continuously in a single-stage process. A suitable device is described. The starting material - preferably a phosphate supension - is dried, melted (if desired, with SiO_2 or B_2O_3 additions), refined and then separated into particles with the aid of nozzles from which the melt emerges in droplets. These particles congeal on a moving surface which also transports them away.

24098 Method for solidifying radioactive materials. Dosch, R.G. (to Energy Research and Development Administration). German(FRG) Patent 2,554,891/A/. 16 Jun 1976. 29p. (In German).

2 figs.; 6 tabs. Available from Dt. Patentamt, Muenchen (FRG).

The invention describes a process to solidify materials, e.g. of radioactive liquid wastes, where according to the invention, complex anions of the general formula $(Msub(x)Osub(y)Hsub(z))^-$ are made to react with cations in these materials and precipitates are thus formed. Four anionic species are used, namely $(Ti_2O_5H)^-$, $(Zr_2O_5H)^-$, $(Nb_2O_6H)^-$ and $(Ta_2O_6H)^-$. The product tetra-methyl ammonium titanate is refered to in the description of the invention where other salt cations may also be used such as NH_4, Li, Mg, Al etc. The preparation of the products used for the nuclear waste solidification reaction is described by two possible processes as well as their practical use. The reaction mechanism in this exchange process is not known, especially why anions are suitable for the formation of the precipitate with the $(Msub(x)Osub(x)Hsub(z))^-$ group, but his exchange and precipitation takes place. An evaporation and calcination step as used in hitherto known solidification processes is not necessary in the suggested method.

24099 Procedure for the processing of radioactive wastes. Durcak, H. (to Kernkraftwerk RWE-Bayernwerk G.m.b.H.). German(FRG) Patent 1,767,999/B/. 8 Jul 1976. 2p. (In German).

Available from Dt. Patentamt, Muenchen (FRG).

This process for processing iodine, barium, strontium and heavy metals containing radioactive liquid wastes is particularly suitable for regeneration liquid wastes from ion exchangers. Carrier solutions of the corresponding non-active ions are thus added for the element to be separated off, and carrier and radioactive elements are precipitated group-wise depending on the adjusted pH value. Finally, all precpitates are filtered off together. Number, kind and quantity of the added carrier per cm^3 liquid waste are also part of the patent.

24100 Process for calcination of radioactive wastes containing sodium nitrate. Newby, B.J. (to Energy Research and Development Administration). German(FRG) Patent 2,603,157/A/. 29 Jul 1976. 15p. (In German).

3 tabs. Available from Dt. Patentamt, Muenchen (FRG).

A method is dealt with for the calcination of liquid, sodium nitrate containing radioactive wastes in which by adding iron to the nitric acid solution, one can prevent a particle agglomeration during the calcination in a fluidized bed. The iron addition should be great enough so that at least 0.5 mols iron per 1 mol sodium nitrate is achieved. The calcination takes place at a temperature of 400°-1,000°C.

24101 Vitrification of high radioactive wastes. Solidification of fission product solutions - a contribution to the safety of the external fuel cycle. Laser, M. *VDI (Ver. Dtsch. Ing.) Nachr.;* 30: No. 36, (Sep 1976). (In German).

2 figs.

The FIPS process (Fission Product Solidification) has been developed in the Nuclear Research Plant, Juelich, for the solidification of highly radioactive wastes. The transferring of the HAW from the reprocessing into a glass or ceramic-like material is carried out in the following process stages. Pre-concentration in an evaporater to an acid concentration of about 5 M, denitration by adding formaldehyde (part decomposition of the nitric acid to nitrogen oxides), addition of vitrification agents (soda, borax, silicic acid, line), solidification of the sludge with a roller dryer and glass melting. In 1978, FIPS will be available for the removal of wastes of the reprocessing pilot plant Jupiter.

24102 Incentives for partitioning high-level waste. Burkholder, H.C.; Cloninger, M.O.; Baker, D.A.; Jansen, G. (Battelle Pacific Northwest Labs., Richland, WA). *Nucl. Technol.;* 31: No. 2, 202-217(Nov 1976).

Safety incentives for separating eliminating various elements from high-level radioactive waste prior to final geologic isolation were examined. The study required evaluation of numerous parameters concerning the transport of radioactivity from the geologic isolation repository to humans. The values used were either consistent with current knowledge or were selected to maximize the calculated potential radiation doses. Thus, incentives for removing various elements from the waste were greatly increased. Also, incentives were greatly overestimated by neglecting all short-term risks and by assuming that elements removed from the waste could be eliminated from the earth without risk. Despite these conservative assumptions, the study found that for reasonable isolation conditions, the potential incremental radiation doses would be of the same order as or less than doses from natural sources. Although not a comprehensive evaluation or partitioning incentives, the study does show that incentives for removal of any elements, including the transuranics, from high-level waste do not exist for the situations investigated. The methods developed for this study can be applied to evaluate any combination of waste type and geologic medium at sites that are candidates for the isolation of nuclear waste materials. (9 figures, 5 tables)

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 24120, 24489, 24729

24103 (ARH-ST—140) Conceptual and mathematical modeling of the Hanford groundwater flow regime. Arnett, R.C.; Deju, R.A.; Nelson, R.W.; Cole, C.R.; Gephart, R.E. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Oct 1976. Contract E(45-1)-2130. 116p. Dep. NTIS $5.50.

Disposal of radioactive wastes to surface disposal sites at the Hanford Atomic Reservation has resulted in some radioactive and chemical contamination of the underlying groundwater flow systems. In support of the Hanford groundwater management effort a preliminary conceptual model of the groundwater system has been formulated as a first step in understanding possible contaminant movement. The mathematical modeling capabilities needed for better understanding and prediction of such contaminant movement are discussed in this paper and the state-of-the-art in groundwater modeling as related to Hanford is summarized with emphasis upon computer solution methods. An inventory of potentially applicable codes available both at Hanford and elsewhere is included. The areas where groundwater modeling capability is lacking are outlined, and the steps needed to overcome such deficiencies are discussed.

24104 (TID—27222) Savannah River Plant Bedrock Waste Storage Project. Interim preliminary conceptual analysis report. (Parsons, Brinckerhoff, Quade and Douglas, Inc., New York (USA)). Jul 1972. Contract E(07-2)-1;SUB-AXC-26729-1/2. 253p. Dep. NTIS $9.00.

The Interim Preliminary Conceptual Analysis Report contains sections on hydrological considerations, chemistry considerations, thermal considerations, Triassic Basin exploration program, and recommendations for additional study. (LK)

24105 (TID—27228) Savannah River Plant Bedrock Waste Storage Project. Interim preliminary conceptual analysis report. Supplement number 1. VI. Rock mechanics considerations. X. Triassic Basin geological considerations. (Parsons, Brinckerhoff, Quade and Douglas, Inc., New York (USA)). Nov 1972. Contract E(07-2)-1;SUB-AXC-26729-1/2. 424p. Dep. NTIS $11.00.

Supplement No. 1 comprises two sections: rock mechanics considerations and Triassic Basin geological considerations. (LK)

24106 (TID—27341) Shallow land burial of low-level radioactively contaminated solid waste. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). 1976. 158p. Dep. NTIS $6.75.

This report is the result of a study of the conditions, practices, and problems involved in the near-surface ground burial by the USAEC of low-level radioactive solid waste. Comments and recommendations are made on practices used by operators of commercial land burial sites. The problem of permanent disposal of transuranium waste is discussed. The need for more studies of groundwater movement is pointed out (the solid waste at ORNL and SRP is being slowly leached). The role of the Federal Government and the coordination of its various agencies is touched upon. (DLC)

24107 (Y/OWI/SUB—76/99096) Systems analysis of instrumentation for in situ examination of rock properties. Final report. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Advanced Energy Systems Div.). Oct 1976. Contract W-7405-ENG-26;PO-86Y-99096V. 122p. (WANL-TME—2877). Dep. NTIS $5.50.

If salt beds or shale beds are used for burial of nuclear wastes, then boreholes that penetrate the beds will be sealed to prevent transport of water into the beds via the boreholes. There will be interest in monitoring the environment in local regions of the borehole for years to come. Such monitoring may be aimed at providing assurance that the integrity of the borehole plug and the integrity of borehole wall seals have not degraded. Of course, there will be interest in monitoring the burial vault geology as well, and the results of this study are relevant to this requirement also. A study of buried instrumentation in boreholes without any wires between the buried instruments and the surface of the earth was performed. Consequently, buried power supplies and through-the-earth commu-

nications systems are required. Study ground rules included the following: burial depths to range between 150 m and 1500 m; maximum temperature of 100°C at the burial depth; and system target lifetime of 10 to 100 years. The instrumentation system is separable into four functional subsystems: (A) a basic instrument subsystem; (B) a command, control, and data processing (CCD) subsystem; (C) a communication subsystem; and (D) a power supply subsystem. The major findings of the study are listed by subsystem. (WHK)

24108 (LA-tr—76-25) **Handling and disposing of radioactive wastes: review of a special seminar for journalists.** Witte, K. Translated from *At. Strom;* **21**: No. 9/10, 115-119(1975). 15p. Dep. NTIS $3.50.

This seminar was held on May 26-27, 1975, at Karlsruhe in order to introduce media people with very little technical background to the processing and final storage of radioactive waste. The five lectures covered: use of radionuclides, principles of reprocessing of fuels, handling of waste, final storage, and environmental safety. The roles of IAEO and the West German Federal Ministry of the Interior are described. This document presents a summary of the lectures. 4 figures (DLC)

24109 Chemical durability of glasses suitable for the storage of high level radioactive wastes. I. On the mechanism of dissolution of the glasses of borax-alumina-silica system in water. Terai, R.; Hara, S.; Kawamoto, T. (Government Industrial Research Inst., Osaka, Ikeda (Japan)); Nanbu, T.; Nakamura, T. *Osaka Kogyo Gijutsu Shikenjo Kiho;* **26**: No. 3, 118-130(Sep 1975). (In Japanese).

To develop the glassy materials suitable for the long-term storage of high level radioactive wastes, the chemical durability of the glasses of borax-alumina-silica system has been investigated. The test was carried out by the following three ways, (1) glass-disk immersion method, (2) continuous leach method and (3) method prescribed in JIS-R3502. In the continuous leach method, glass grains were exposed to circulating water at a constant temperature for a week to obtain the leach factor or leach rate. It was found from the experimental results that, as the silica content increased, the melting temperature of the glasses progressively increased and the chemical durability was considerably improved, and that B_2O_3 and Na_2O constituents were preferentially dissolved in water leaving relatively insoluble components such as SiO_2 and Al_2O_3. The rate at which B_2O_3 and Na_2O in glass are leached out is governed by three processes, that is, (1) the boundary reaction on the glass surface, (2) the diffusion process through the hydrated layer, and (3) the disintegration of hydrated layer. The first process probably corresponds to the hydration of boric oxides on the glass surface or to the ion exchange between protons in solution and Na^+ ions in glass, and the second process seems to correspond to the diffusion of protons through the hydrated layer on the glass surface. Although the ratio of $[Na\text{-}BO_4]/[BO_3]$ in the borax-silica glasses was determined to be 0.5 by means of NMR measurement, Na_2O/B_2O_3 ratio in leached solution was less than 0.5, indicating that $[BO_3]$ groups in glass were more soluble than $[Na\text{-}BO_4]$ groups. From the viewpoint of appreciation of safety, the chemical durability of the glasses of borax-aluminasilica system was rather unsatisfactory, but that of the glasses containing silica in quantities was comparable to the soda-lime silicate sheet glasses.

24110 Legal and administrative problems related to the treatment and disposal of radioactive wastes. Cornelis, J.C. (Ministerie van Volksgezondheid en Milieuhygiene, Leidschendam (Netherlands)). pp 226-230 of In Nuclear Inter Jura 75 Proceedings. Paris; International Nuclear Law Association (1976).

From Nuclear Inter Jura 75 Congress; Aix-en-Provence, France (29 Sep 1975).

The consequence of the rapid expansion of nuclear power programs is that the quantity of radioactive wastes will increase in proportion. These wastes are produced during the different stages of the fuel cycle. The management of these wastes raises certain legal problems particularly regarding the methods for final storage or for sea disposal. All these management methods have an international incidence and these aspects must be studied in step with technical problems.

24111 Radioactive waste disposal. Pelzer, N. (Goettingen Univ. (Germany, F.R.). Inst. fuer Voelkerrecht). pp 225-238 of In Viertes deutsches Atomrechts-Symposium. Referate und Diskussionsberichte. Cologne; Heymanns (1976). (In German)

From 4. German symposium on nuclear law; Goettingen, Germany, F.R. (26 May 1975).

With refs.

The result of a critical appreciation of the draft of the Radiation Protection Ordinance can be summarized as follows: although the draft, particularly sect. 45 thereof, proposes purposeful individual regulations, it still has not been possible to create a convincing and closed total system of waste disposal. This is mainly due to the fact that the unfortunate system of the present law, i.e. the inclusion of disposal into handling, was maintained. As the draft did not detach itself from this model and because of the legal fixation of this model in sect. 11 par. 1 no. 1 AtG this was probably, possible either a complete new concept was not achieved. Principles for new waste disposal regulations are proposcd.

24112 Method for the conditioning of high level radioactive wastes for their safe storage and disposal. van Geel, J.; Eschrich, H.; Detilleux, E. (to Societe Europeenne pour le Traitement Chimique des Combustibles Irradies (EUROCHEMIC), Mol (Belgium)). British Patent 1,446,016/B/. 11 Aug 1976. 10p.p.

A method is described for the treatment of solidified high level radioactive wastes to enable them to be safely stored or disposed of in an approved manner. The solidified waste is embedded in a matrix of pure metals or metal alloys. The metals may be Pb, Pb/Sb alloys, Pb/Sn alloys, Pb/Bi alloys, Pb/Zn alloys, or mixtures of these, or Al, Al/Si alloys, Al/Mg alloys, Al/Cu alloys, or mixtures. The matrix is clad with non-corrosive material, selected from stainless steel, Ti, Pb, Pb alloys, Al, Al alloys, or mixtures of same. A non-corrosive container is filled with the solidified waste and is heated to above the melting temperature of the metallic matrix material used to embed the waste. The matrix material is then added and the container is cooled. The container may then be degassed. The solidified waste feed may be in the form of a vitreous material containing the high level waste; this vitreous material may consist of a lead borosilicate or a mixture of non-lead borosilicates and phosphate glasses, and the method of preparing it is described.

24113 (BNWL-tr—224) **Actinides in glasses.** Bonniaud, R. Translated from *Bull. Inf. Sci. Tech. (Paris);* No. 217, 47-53(Sep 1976). 20p. Dep. NTIS $3.50.

The influence of actinides on glasses intended to contain the activity of wastes produced by reprocessing plants was studied with glasses doped with α-emitters. The initial results are given. The problem posed by the duration of containment is discussed by comparison with ores.

24114 (BNWL-tr—221) **Problems in the safe disposal of alpha-containing wastes from reprocessing and fuel-assembly fabrication, exemplified by the long-term behavior of highly active glasses.** Scheffler, K.; Riege, U.; Hild, W.; Jakubick, A.T. (Kernforschungszentrum Karlsruhe (Germany, F.R.)). Dec 1976. Translation of KFK—2170. 61p. Dep. NTIS $4.50.

Questions of long-term safety in ultimate storage of radioactive wastes are discussed on the basis of the concentrations of alpha-emitters in the waste, the relative toxicity of those alpha-emitters, and the stability of the solidified products towards the energy released by disintegration of the alpha nuclides. In this context, a review is given of all alpha-containing waste categories produced during reprocessing and refabrication. As an example, the long-term behavior of highly active glasses is discussed and investigated in an accelerated test with representative ^{242}Cm glasses.

24115 (BNWL-tr—222) **Energy storage in borosilicate glasses.** Scheffler, K.; Riege, U.; Hild, W. (Kernforschungszentrum Karlsruhe (Germany, F.R.)). Dec 1976. Translation of KFK—2333. 25p. Dep. NTIS $3.50.

The influence of alpha and beta/gamma emitters on energy storage in borosilicate glasses during ultimate storage is discussed. The long-term effects are simulated in accelerated tests with borosilicate glasses having the typical composition of highly active glasses and spiked with 2.6-Ci ^{242}Cm/g glass. The stored energies are measured as a function of dose up to an accumulated dose corresponding to 2×10^{18} alpha disintegrations per g of glass, at which the saturation range is reached. The method for measuring stored energies in a DTA apparatus is described in detail.

24116 (BNWL-tr—220) **Study of the diffusion of radioactivity of glasses and bituminous coatings.** Rodier, J.; Marichal, M.; Benoit, R.; Niezborala, F.; le Bouhellec, J. (CEA, 75 - Paris (France)). 22 Dec 1976. Translation of CEA-R—3751. 37p. Dep. NTIS $4.00.

Three series of tests were performed. One series of preliminary tests used two glass blocks each containing about 200 Ci, immersed in water pumped in closed circuit. After a certain time, one of the blocks was transferred into a column of soil, with the goal of observing the retention of contaminating products released by leaching of the block. In this test, only total radioactivity was measured. A second series of tests used three glass blocks each containing about 1000 Ci, and a comparative study of leaching conditions in replaced, stagnant, and running water was undertaken. A third series of tests was aimed at studying leaching of blocks solidified by different processes as a function of the normal precipitation of the region and taking account of a soil capable of receiving the coated wastes. (LK)

24117 (ORNL-tr—4202) **Seven years of experience in storage of solid radioactive wastes of low and medium activity on the surface or in concrete ditches.** Bardet, G. (Societe INFRATOME, 75 - Paris (France)). 1977. Translation by M. Gerrard of SM-207/39. (CONF-760310—18). 8p. Dep. NTIS $3.50.

From IAEA symposium on the management of radioactive waste; Vienna, Austria (22 Mar 1976).

This experience in the transport and storage of radioactive waste leads to several reflections pertinent to large-scale nuclear installations throughout the world. The experience demonstrates that products of this kind can be centralized and confined by relatively simple processes which are safe and of reasonable cost. The necessary liaison between the producer of radioactive wastes and the group which takes charge of storage is emphasized for the choice of the waste conditioning procedure. It is a consistent part of the experience that the initial conditioning determines in large measure the handling and storage techniques. It is certain that the absence of a solution for long-term storage of radioactive wastes will lead the producers to consider and carry out conditioning which, although valuable, does not have all the same advantages for final disposition of the product. In the field of transport, the volumes and weights are important. It is desirable that a permanent storage center be near a railroad. It is stated that storage can be ensured under safe conditions and with acceptable costs of all solid wastes of low and average activity except those having more than a certain amount of alpha activity. For the latter products a solution can be found which is safe. (DLC)

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 25467

24118 (BNWL—2073) **Balanced program plan. Volume XI. Fission analysis for biomedical and environmental research.** Foster, R.F. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jun 1976. Contract E(45-1)-1830. 119p. Dep. NTIS $5.50.

Factors involved in the formulation of an ERDA-sponsored program for health and environmental research in connection with the fission fuel cycle are discussed under the following section headings: major issues associated with the use of nuclear power; fission fuel cycle technology: milling, UF_6 production, uranium enrichment, plutonium fuel fabrication, power production (reactors), fuel reprocessing, waste management, fuel and waste transportation; problem definition: characterization, measurement and monitoring, transport processes, health effects, ecological processes and effects, and integrated assessment; budget; characterization, measuring and monitoring program units; transport processes program units; health effects program units; ecological processes and effects program units; and integrated assessment program units. (JGB)

24119 (TREE—1013) **Onsite environmental surveillance report for the INEL Radioactive Waste Management Complex. Annual report, 1975.** Harness, J.L.; Passmore, R.W. (EG and G Idaho, Inc., Idaho Falls (USA)). Dec 1976. Contract EY-76-C-07-1570. 28p. Dep. NTIS $4.00.

This report is the second formal report documenting the continuing Idaho National Engineering Laboratory (INEL) Radioactive Waste Management Complex (RWMC) Environmental Surveillance Program. The results of the 1975 monitoring program indicate that operation of the RWMC continues to have a minimal impact on the environment. Soil, water, and air samplings show all radiological impacts of RWMC operation to be well within generally accepted limits.

24120 Migration of radionuclides in a model saturated zone. I. Experiments and discussion. Inoue, Y.; Morisawa, S. (Kyoto Univ. (Japan). Faculty of Engineering). *Nippon Genshiryoku Gakkaishi;* **18**: No. 1, 42-50(Jan 1976). (In Japanese).

Leaching of radionuclides from solidified waste and its migration characteristics are tested using a model sand layer, whose depth 50cm, width 40cm, length 105cm and consist of 306kg sand taken from Japan Atomic Energy Research Institute, Tokai Site. Model solidified waste (19.6cm dia. and 50cm height), solidified with portland cement containing seven nuclide (^{90}Sr, ^{137}Cs, ^{60}Co, ^{65}Zn, ^{54}Mn, ^{59}Fe and sup(110m)Ag), is set in the saturated sand layer and the concentration of nuclides in a pore water of the layer is checked after specific intervals of time. After about 1,280 days, the saturated sand layer is taken to pieces and a distribution of a nuclide in a bedded sand is also checked. The results obtained through this experiment are as follows: (1) Among seven radio-nuclides, only ^{90}Sr are detected in both pore water and bedded sand. (2) The distribution of ^{90}Sr in a pore water of the layer becomes steady after about 500 days. This steady distribution is closely related to the steady leaching of ^{90}Sr out of solidified waste. (3) First stage leaching of ^{90}Sr out of solidified waste close after the contact with water is large, but it results in flat distribution rapid as the nuclide migrates through a sand layer, which means a large ^{90}Sr exchange capacity of bedded sand. (4) Theory of Ksub(f)-factor depicts well a migration rate of ^{90}Sr in a model saturated sand layer.

24121 Analysis of an analytical technique for distributing air sampling locations around nuclear facilities. Waite, D.A. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). *Health Phys.;* **31**: No. 3, 247-250(Sep 1976).

A new analytical method for distributing air sampling locations around nuclear facilities (including reactors, fuel fabrication plants, and fuel reprocessing and research centers) incorporates a weighting factor based on demographic and meteorologic data. The initial sampling location distributions recommended by this approach show high correlations with sampling locations in well-established air monitoring programs throughout the world. The method provides a consistent, uncomplicated and economical way to incorporate the past experiences of more refined programs into the environmental surveillance programs of new or developing installations.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 24065, 24075, 24118, 25337

REGULATIONS

REFER ALSO TO CITATION(S) 24110, 24489

24122 Radioactive marine pollution. Pontavice, E. du (Paris-11 Univ., 91 - Orsay (France)). pp 119-137 of In Nuclear Inter Jura 75 Proceedings. Paris; International Nuclear Law Association (1976). (In French)

From Nuclear Inter Jura 75 Congress; Aix-en-Provence, France (29 Sep 1975).

Certain provisions in international law aim to prevent radioactive marine pollution and others concern compensation of damage from nuclear pollution. Prevention requires regulation of the disposal of wastes from nuclear industry from the operation of nuclear powered ships and from transport of fissile materials. As regards damage, if the measures to limit the extent of the damage come under the law of the sea, the priority of nuclear law over maritime law is clear in respect of financial compensation.

ACCOUNTABILITY AND SAFEGUARDS

REFER ALSO TO CITATION(S) 24128

24123 (SAND—76-0522) **Programmer's description of the Barrier Data Base.** Wall, D.W.; Jones, R.E.; Worrell, R.B. (Sandia Labs., Albuquerque, N.Mex. (USA)). Dec 1976. Contract EY-76-C-04-0789. 27p. Dep. NTIS $4.00.

The Barrier Data Base is a body of information concerning different kinds of barriers that are used in safeguarding nuclear materials and installations. The two programs written for creating, updating, and manipulating the Barrier Data Base are discussed. The BARRIER program is used to add, delete, modify, display, or search for specific data in the data base. A utility program named NUMBER is used to compress and renumber the barrier and threat tables. (LK)

24124 Effect of safeguards on the contractual relations of nuclear suppliers. MacIsaac, J.F.D. (Atomic Energy Control Board, Ottawa, Ontario (Canada)). pp 188-191 of In Nuclear Inter Jura 75 Proceedings. Paris; International Nuclear Law Association (1976).

From Nuclear Inter Jura 75 Congress; Aix-en-Provence, France (29 Sep 1975).

Canada applies a safeguards system aimed to ensure that nuclear materials and equipment are not diverted from their peaceful uses. These control requirements have a direct influence on the conditions of export contracts concluded by Canadian suppliers of nuclear materials or equipment. In particular if the buyer does not comply with the safeguards clauses, it may not be possible for the Canadian supplier to fulfill the contract. This possibility is covered by the force majeure clauses.

24125 Present status of the Treaty on the non-proliferation of nuclear weapons. Netchaev, B. (International Atomic Energy Agency, Vienna (Austria)). pp 236-237 of In Nuclear Inter Jura 75 Proceedings. Paris; International Nuclear Law Association (1976).

From Nuclear Inter Jura 75 Congress; Aix-en-Provence, France (29 Sep 1975).

The Treaty for the Non-Proliferation of Nuclear Weapons plays an important role in enhancing the security of all States. It is essential to maintain in the implementation of the Treaty an acceptable balance of the mutual responsibilities and obligations of all the countries Party to the Treaty wether or not nuclear weapon States. These questions were discussed during the Conference on the operation of the Treaty held in Geneva in May 1975. It was emphasized at the Conference that the first five years of application of the Treaty had shown a consistent increase in the number of ratifications and in the safeguards agreements concluded on the basis of the Agreement.

24126 Non-destructive measurement of plutonium and uranium in process wastes and residues. McDonald, B.J.; Fox, G.H. (British Nuclear Fuels Ltd., Windscale); Bremner, W.B. (UKAEA Reactor Group, Dounreay). pp 589-597 of In Safeguarding nuclear materials. Vol. II. Vienna; IAEA (1976).

From Symposium on the safeguarding of nuclear materials; Vienna, Austria (20 Oct 1975).

Routine methods used for measurement of the plutonium and uranium content of wastes and residues are described. In the case of combustible waste an automated monitor measuring the plutonium input to an incinerator, and exercising criticality control over the plant, is discussed. Methods used for plutonium and uranium measurement of large and small volumes of waste include gamma spectrometry and neutron interrogation. Process residues, mostly as fuel cladding (hulls) are an important item in plant accountancy and process control. Routinely used techniques are described for determination of ^{235}U in fast reactor fuel hulls and of residual fuel in thermal oxide fuel hulls. Plant experience, precision, accuracy, and possible errors are discussed. The use of an isothermal calorimeter for criticality and plant accountancy on process slags is discussed.

24127 Recent developments in the dissolution and automated analysis of plutonium and uranium for safeguards measurements. Jackson, D.D.; Marsh, S.F.; Rein, J.E.; Waterbury, G.R. (Los Alamos Scientific Lab., N.Mex. (USA)). pp v.2 p.91-105 of In Safeguarding nuclear materials. Vienna; IAEA (1976).

From Symposium on the safeguarding of nuclear materials; Vienna, Austria (20 Oct 1975).

The status of a program to develop assay methods for plutonium and uranium for safeguards purposes is presented. The current effort is directed more towards analyses of scrap-type material with an end goal of precise automated methods that also will be applicable to product materials. A guiding philosophy for the analysis of scrap-type materials, characterized by heterogeneity and difficult dissolution, is relatively fast dissolution treatment to carry out 90% or more solubilization of the uranium and plutonium, analysis of the soluble fraction by precise automated methods, and gamma-counting assay of any residue fraction using simple techniques. A Teflon-container metal-shell apparatus provides acid dissolutions of typical fuel-cycle materials at temperatures to 275°C and pressures to 340 atm. Gas-solid reactions at elevated temperatures are promising to separate uranium from refractory materials by the formation of volatile uranium compounds. The condensed compounds then are dissolved in acid for subsequent analysis. An automated spectrophotometer has been placed in operation for the determination of uranium and plutonium. The measurement range is 1 to 14 mg of either element with a relative standard deviation of 0.5% over most of the range. The throughput rate is 5 min per sample. A second-generation automated instrument, which will use a precise and specific electro analytical method as its operational basis, is being developed for the determination of plutonium.

ADMINISTRATIVE AND REGULATORY

REFER ALSO TO CITATION(S) 24078, 24079, 25733, 25734, 25736, 25738, 25740

24128 Nuclear Fuel Assurance Act of 1975, S. 2035 and H.R. 8041 Hearings before the Joint Committee on Atomic Energy. U.S. Congress, Ninety-Fourth Congress, Second Session, February 6, March 23, April 6 and 7, 1976. Washington, DC; Joint Committee on Atomic Energy (1976). 461p. GPO.

The prospect of allowing private ownership and operation of future enrichment facilities was considered. Henry Kissinger testified on the necessity of adequate enrichment capability and on the foreign policy aspects of the proposed Nuclear Fuel Assurance Act. Representatives from several power organizations concentrated on the economic aspects of private envolvement in nuclear fuel enrichment. A few accounts of private investment in gas centrifuge development were given. (DDA)

24129 Public announcement of the promulgation of the Nuclear Third Party Liability Convention including supplementary conventions. *Bundesgesetzblatt, Teil 2;* No. 12, 308-309(Feb 1976). (In German).

According to article 4 paragraph 2 of the act of July 8th, 1975 concerning the Convention on Third Party Liability including the Supplementary Conventions dated July 29th, 1960, concerning the Convention the Liability of Operators of Nuclear Ships and its Additional Protocol dated May 25th, 1962, and concerning the Convention relating to Civil Liability in the field of Maritime Carriage of Nuclear Material it is thus announced that 1) the Convention dated July 29th, 1960 on Third Party Liability in the Field of Nuclear Energy and its Additional Protocol dated January 28th, 1964 according to its article 19, 2) the Supplementary Convention to the Paris Convention dated July 29th, 1960 on Third Party Liability in the Field of Nuclear Energy and its Additional Protocol dated January 28th, 1964 according to its article 20 have taken effect for the FRG with reference to 1) on September 30th, 1975, with reference to 2) on January 1st, 1976.

24130 Public announcement of the amended version of the Paris Nuclear Third Party Convention and the Brussels Supplementary Convention. *Bundesgesetzblatt, Teil 2;* No. 12, 310-322(Feb 1976). (In German).

According to article 4 paragraph 3 of the act concerning the Paris and Brussels Nuclear Third Party Liability Conventions of 8th July 1975 the text is announced of a) the Convention of 29th July 1960 on Third Party Liability in the field of Nuclear Energy, taking into account amendments by the Additional Protocol of 28th January 1964, and b) the Supplementary Convention of 31st January 1963 to the Paris Convention of 29th July 1960 on Third Party Liability in the field of Nuclear Energy, taking into account amendments by the Additional Protocol of 28th January 1964.

FUSION FUELS

PROCESSING

24131 (HEDL-TME—76-81) Extraction of tritium from lithium aluminate. Yunker, W. (ed.). (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1976. Contract E(45-1)-2170. 79p. Dep. NTIS $5.00.

Complete data are presented for the extraction of tritium from neutron irradiated lithium aluminate pellets. Two methods were used: (a) thermal/vacuum extraction at temperatures up to 980°C and (b) dissolution of the pellets in sodium tetraborate at 850°C followed by vacuum extraction. Approximately 1 percent of the tritium was in a noncondensable (at -195°C and 10^{-3} torr) form. Extraction efficiency was greater than 95 percent.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 25167

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

PHYSICAL ISOTOPE SEPARATION

24132 (UCRL—77981) Some aspects of the laser isotope separation program at Lawrence Livermore Laboratory. Davis, J.I.; Davis, R.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Nov 1976. Contract W-7405-ENG-48. 23p. (CONF-761109—9). Dep. NTIS $3.50.

From 69. annual meeting of the AICHE; Chicago, Illinois, United States of America (USA) (28 Nov 1976).

The history and state-of-the-art of laser isotope separation at the Lawrence Livermore Laboratory are reviewed. (TFD)

RADIATION SOURCES

DESIGN AND FABRICATION

24133 Monochromator and method for manufacturing same. Schoenborn, B.P.; Caspar, D.L.D. (to Energy Research and Development Administration). French Patent 2,275,857/A/. 18 Jun 1975. 18p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 20 Jun 1974, US.

The monochromator according to the invention is characterized by a plane support that does not absorb neutrons, and on which are deposited layers of two different metals, such as germanium and manganese, the thickness of which permits to achieve desired neutron-diffusion densities with a view to focusing a narrow neutron beam onto a detector. Such a monochromator is suitable, in particular, for determining the arrangement of atoms in a complex lattice, e.g. of myoglobin, sciatic nerve fibers, or the like.

OTHER INDUSTRIAL USES

REFER ALSO TO CITATION(S) 24963

24134 (ERDA—77-17) Beneficial use of waste nuclear isotopes: 137 cesium irradiation treatment of municipal sludge and compost. An

executive summary report. Remini, W.C.; Wahlquist, E.J.; Sivinski, H.D. (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Nuclear Research and Applications; Sandia Labs., Albuquerque, N.Mex. (USA)). 5 Jan 1977. 18p. Dep. NTIS $4.00.

The sludge irradiation program is a part of a larger effort to develop beneficial uses of individual isotopes or combinations of isotopes contained in the reactor wastes. Sludge irradiation using ^{137}Cs offers what appears to be near-term benefits and has received the major focus in this program. The progress and current status of the program are reviewed. The two major approaches, wet and dry irradiation, are described and their technical and economic potential is discussed. Finally, the status of on-going efforts to experimentally apply irradiated sludges are summarized and a projected development plan is outlined. The results of the studies conducted to date indicate that sludge irradiation on a large scale could become an important and economically viable process. The basic irradiation technology exists. The need for improved sludge management is universally recognized and the existence of sufficient quantities of ^{137}Cs in the reactor wastes appears destined to occur. The uncertainties involve the specific economics of extracting the cesium from the wastes and the cost effectiveness and practicality of the irradiation process in competition with other potential sludge treatment methods. Efforts are being focused on these aspects of the program.

ISOTOPIC POWER SUPPLIES

24135 (BMI-X—673) **Experimental screening of carbon-base materials for impact members in isotopic heat sources.** Bansal, G.K.; Duckworth, W.H. (Battelle Columbus Labs., Ohio (USA)). Nov 1976. Contract W-7405-ENG-92-TAS-67. 37p. Dep. NTIS $4.00.

Fourteen C/C composites and three reentry-grade bulk graphites were evaluated experimentally to determine their applicability for impact member use in radioisotope heat sources. The composites included the following generic types: (1) 2-D cloth lay-ups; (2) 2-D and 3-D felts; (3) 3-D weaves; (4) 3-D pierced fabrics; (5) 7-D weave; and (6) coarse polar weave. Also included was the 2-D randomly wound, resin-impregnated C/C material presently used as the impact member in the MHW RTG and commonly designated "GIS" (an acronym for graphite impact shell). The various materials were evaluated as energy absorbing materials. None of the materials in these tests performed appreciably better than the GIS impact member material now used in the MHW heat source, HITCO Pyro Carb 814. Two cloth lay-up composites, HITCO's Pyro Carb 903 and Carborundum's Carbitex 700, were somewhat superior in performance, while the bulk graphites and felt-base composites ranked least effective as energy absorbers. All experimental data and other factors considered to date suggest that Pyro Carb 903 is the best prospect for a bifunctional heat shield and impact member. Its high density (1.80 g/cm^3) indicates potentially good ablation resistance to accompany its indicated good performance as an energy absorber.

24136 (COO—3043-26) **Nuclear-powered artificial heart prototype system development program. Quarterly progress report, July 1, 1976—September 30, 1976.** (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Advanced Energy Systems Div.). 1976. Contract EY-76-C-02-3043. 128p. Dep. NTIS $6.00.

Technical progress and accomplishments on the active tasks are reported. The tasks include: 35-thermal insulation and thermal protection; 36-thermal converter; 37-flexible shaft, bearing and lubricant; 38-thermal and hydraulic research; 39-system integration and interfacing; 40-IVBM system performance testing; 41-IVBM system fabrication; 42-Added IVBM blood pumps fabrication; 43-IVBM system life testing; and 46-quality assurance activities. (TFD)

24137 (GE-BIPS—20-001) **Mission environments for the Isotope Brayton Flight System (preliminary).** (AiResearch Mfg. Co. of Arizona, Phoenix (USA)). 8 Aug 1975. Contract EY-76-C-03-1123. 59p. Dep. NTIS $4.50.

The mission environments for the Isotope Brayton Flight Systems (IBFS) are summarized. These are based on (1) those environments established for the MHW-RTG system in the LES 8/9 and Mariner J/S and (2) engineering projections of those likely to exit for the IBFS. The pre-launch environments address transportation, storage, handling and assembly (to spacecraft) and checkout, field transportation, and launch site operations. Launch environments address the Titan IIIC and Shuttle launch vehicles. Operational mission environments address normal space temperature and meteoroide environments. Special environments that may be applicable to DOD missions are not included. Accident environments address explosion and fire for the Titan IIIC and the Shuttle, reentry, earth impact and post impact.

24138 (GE-BIPS—71-001) **Quality assurance plan for Isotope Brayton Ground Demonstration System program. Phase I.** (AiResearch Mfg. Co. of Arizona, Phoenix (USA)). 15 Jan 1976. Contract EY-76-C-03-1123;SUB-P-397975. 34p. Dep. NTIS $4.00.

The Quality Assurance Plan describes the program to be performed in the fulfillment of the ERDA Isotope Brayton Ground Demonstration System Contract quality requirements. The Plan is designed to provide effective controls which will result in contractually compliant end items for all phases of the contract from Customer specification thru design, procurement, manufacture, utilization and test of Ground Demonstration System hardware.

24139 (GE-BIPS—72-002) **Reliability program plan for isotope Brayton Ground Demonstration System program. Phase I.** (AiResearch Mfg. Co. of Arizona, Phoenix (USA)). 4 Dec 1975. Contract EY-76-C-03-1123;SUB-P-397975. 18p. Dep. NTIS $3.50.

The purpose of the BIPS Reliability Program for Phase I is to assure that optimum reliability is designed into the hardware. Primary emphasis will be placed on early identification of design and fabrication problems which could compromise high reliability in General Electric supplied equipment. Solutions to these problems will be integrated by reliability among design and program disciplines. The specific areas of Ge reliability support to the Phase I effort include: (1) design of radiator and HSA interfaces; (2) fabrication and assembly of radiator, heat sink heat exchanger and three electric heat sources; (3) bimetallic joint development; (4) integration of major components in the GDS; and (5) design and fabrication of special test and ground support equipment.

24140 (GE-BIPS—73-001) **BIPS: transient probability study.** (AiResearch Mfg. Co. of Arizona, Phoenix (USA)). 13 Nov 1975. Contract EY-76-C-03-1123;SUB-P-397975. 37p. Dep. NTIS $4.00.

A study has been completed to determine the probabilities for re-entry of a spacecraft employing the Brayton Isotope Power System (BIPS) coincident with a temperature excursion or transient in the BIPS due to loss of either auxiliary cooling or the working fluid. The purpose of the study was to arrive at the most probable state of the transient, considering operation of the Emergency Cooling System (ECS), immediately prior to re-entry as influenced by the total spectrum of launch vehicle malfunctions. The results of the study have been used to establish the test conditions to be effected in the transient test of the ECS to be conducted in the NASA Heat Source Assembly (HSA) Program.

DESIGN AND FABRICATION

24141 (DP-MS—76-30) **Californium-252 sources for afterloading.** Permar, P.H.; Boulogne, A.R.; Mosley, W.C. Jr.; Walker, V.W. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1976. Contract E(07-2)-1. 29p. (CONF-760436—7). Dep. NTIS $4.00.

From International symposium on californium-252 utilization; Paris, France (26 Apr 1976).

Californium-252 neutron sources have been developed to investigate the value of this radionuclide in cancer therapy. The primary objective of the neutron source development is to meet the changing needs of the radiotherapist with safe, reliable, and uniform products. Thus far point and line sources containing 0.5 microgram to 1.0 milligram of californium-252 have been designed. The neutron source forms that are now available are reviewed, and the techniques by which they are fabricated are discussed. Many new combinations and configurations of californium-252 neutron sources are possible, if needed by the medical evaluators of this radioisotope. Californium-252 neutron sources are loaned by the United States Energy Research and Development Administration (ERDA) for medical research. Californium-252 sources are also loaned by ERDA for clinical investigations under a protocol of the Radiation Therapy Oncology Group, U.S. National Cancer Institute.

24142 (DPST—76-128-12) **Savannah River Laboratory monthly report: ^{238}Pu fuel form processes.** (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Dec 1976. Contract E(07-2)-1. 24p. Dep. NTIS $3.50.

A study of the causes of crack formation in MHW spheres has shown: (1) self-heating and thermal shock are major causes of the rapid formation of large cracks; (2) phase transformations are capable of producing small, localized cracks; and (3) differential sintering, internal oxidation of carbon, and alpha-decay helium probably contribute to crack growth. Interim heat treatments of MHW 80%-dense $^{238}PuO_2$ pellets at 6-month intervals effectively release helium without causing microstructural damage. Pellets stored for 10 months or more without heat treatment show grain-boundary separations when heated to 1400°C.

24143 (GE-BIPS—03-001) **Materials compatibility analysis.** Brown, P.E.; DeSantis, V.J.; Sayell, E.H. (AiResearch Mfg. Co. of Arizona, Phoenix (USA)). 26 Nov 1975. Contract EY-76-C-03-1123;SUB-P-397975. 74p. Dep. NTIS $4.50.

The use of the MHW-IHS in the MJS configuration as the heat source for the BIPS-GDS, exposes a bare graphite structure to the inside of the HSHX, the design of which currently uses the niobium alloy, C-103. Data from the MHW-IHS studies showed CO/CO_2 was evolved in storage and under operational conditions,

froom the Carbon/Graphite components which were insufficiently degassed before assembly. A satisfactory method for removing gases from the MHW-IHS has been defined to assure acceptable levels of CO/CO_2 in the MJS converter. However, it is recognized that the Nb and Ta alloys are degraded in their mechanical properties by both carbon and oxygen. Consequently, there is concern that for prolonged exposures, 10^5 hours, the Nb alloy of the HSHX may be adversely affected even by very low concentrations of CO/CO_2, O_2, H_2O, and H_2. A materials evaluation study was begun to review the potential problems and to indicate proposed solutions. The materials evaluation study covered the following activities: (1) defining the scope of MJS-IHS/HSHX potential problem areas for investigation; (2) setting of study objectives and of criteria for evaluating possible solutions; (3) identification of some possible solutions; (4) outlining testing efforts need to verify adequacy of proposed solutions; and (5) recommendations for future work.

24144 (GE-BIPS—30-001) **General Electric preliminary design review data package for BIPS—ERDA PDR.** (AiResearch Mfg. Co. of Arizona, Phoenix (USA)). 1 Jun 1976. Contract EY-76-C-03-1123;SUB-P-397975. 93p. Dep. NTIS $5.00.

Design parameters for Brayton isotope power systems are given in graphical and tabular form. (TFD)

HYDROGEN

REFER ALSO TO CITATION(S) 25508

PRODUCTION

REFER ALSO TO CITATION(S) 24177, 24183, 25668

24145 **Improved solar energy conversion efficiencies for the photocatalytic production of hydrogen via TiO_2 semiconductor electrodes.** Houlihan, J.F. (Pennsylvania State Univ., Sharon); Madacsi, D.P.; Walsh, E.J.; Mulay, L.N. *Mater. Res. Bull.;* **11**: No. 9, 1191-1198(Sep 1976).

Overall solar energy conversion efficiencies of at least 0.8 percent, somewhat greater than those previously reported, have been obtained in the photocatalytic production of hydrogen using TiO_2 semiconductor electrodes prepared by heat treatment of titanium metal foils. A shift in the threshold frequency for hydrogen evolution toward energies slightly lower than the 3.02 eV bandgap of TiO_2 was observed for some of these electrodes. This result supports the possibility of utilizing a greater portion of the solar spectrum, thereby increasing overall conversion efficiency even further. A tentative explanation of this shift involves the presence of mixed phases of the titanium—oxygen system (Magneli phases) in the semiconducting film.

24146 **Method for the generation of hydrogen.** Hohne, K. (to Siemens Aktiengesellschaft). US Patent 3,985,865. 12 Oct 1976. Priority date 3 May 1974, German, Federal Republic of (F.R. Germany). 4p.

The invention provides a method for the generation of hydrogen, particularly for the generation of hydrogen for fuel cells. The hydrogen is generated through reaction of magnesium or a magnesium—aluminum mixture with water in the presence of at least one cobalt oxide and at least one water-soluble chloride, there being additionally admixed to the reaction mixture a molybdenum compound, particularly a molybdenum oxide or a molybdenate.

CHEMISORPTION

REFER ALSO TO CITATION(S) 25002

INDUSTRIAL AND COMMERCIAL USE

REFER ALSO TO CITATION(S) 25000, 25002, 25003

OTHER SYNTHETIC AND NATURAL FUELS

HYDROCARBON FUELS

REFER ALSO TO CITATION(S) 24505

PROPERTIES

REFER ALSO TO CITATION(S) 23981, 25154

24147 (CONF-761047—3) **Oxidation rates in the post-induction period for methane over a wide range of equivalence ratios.** Penner, S.S.; Heffington, W.M.; Parks, G.E.; Sulzmann, K.G.P. (California Univ., San Diego, La Jolla (USA)). 1976. 27p. Univ. of California, San Diego, LaJolla.

From The Combustion Institute meeting; LaJolla, California, United States of America (USA) (18 Oct 1976).

Estimates are presented for the effective oxidation rates of methane over a wide range of equivalence ratios. The rate of disappearance of methane has been monitored in a fuel-rich mixture of methane, oxygen and argon by direct measurements of the change in transmission for He—Ne laser radiation at 3.392 μ behind reflected shock waves. The rate of formation of water with time has been obtained in independent absolute infrared emission measurements near 6.75 μ on stoichiometric CH_4—O_2—Ar mixtures with and without added water. The following data correlations that may be used in the post-induction period for stoichiometric mixtures (equivalence ratio phi = 1) and fuel-rich mixtures with phi = 2 or phi = 4 were found empirically.

PREPARATION

REFER ALSO TO CITATION(S) 23968

24148 **First international conference 'Conversion of refuse into energy'.** Rasch, R. *Aufbereit.-Tech.;* **17**: No. 2, 88-90(Feb 1976). (In German).

From 1. international conference on conversion of refuse into energy; Montreux, Switzerland (3 Nov 1975).

A discussion is given on lectures presented at a meeting on the use of wastes as energy sources. Waste processing by the following methods were discussed: (1) mechanically by processing and briquetting; (2) biologically by anaerobic and aerobic treatment; (3) thermally by drying and degasification (pyrolysis); (4) chemically by gasification (synthesis gas) and hydrogenation; and (5) energetically by gasification (fuel gas) and combustion.

CHEMICAL SYNTHESIS

REFER ALSO TO CITATION(S) 23920

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 24030, 24179, 24182

24149 (COO—2900-6) **Fast production of methane by anaerobic digestion. Progress report, September 24, 1976—October 24, 1976.** Finney, C.D.; Evans, R.S. II; Finney, K.A. (Natural Dynamics, Des Moines, Iowa (USA)). Nov 1976. Contract EY-76-C-02-2900. 6p. Dep. NTIS $3.50.

Three modified five (5) liter standard baffled digesters are constructed and are being loaded with a stock of thermophilic bacteria. Individual digesters will be acclimated to 48, 53, and 58°C at 760 mm mercury absolute for the purpose of determining the effect of temperature on glucose loading rates. During the equilibration period the relative concentrations of acetic, propionic, and butyric acids will be determined in order to monitor any changes in bacterial populations.

24150 **Capturing the sun through bioconversion.** Washington, DC; Washington Center for Metropolitan Studies, 1719 Massachusetts Ave., NW, Washingtn, DC (1976). 860p. (CONF-760354—). $18.00.

From Conference on capturing the sun through bioconversion; Washington, District of Columbia, United States of America (USA) (10 Mar 1976).

General overview status reports, papers on biomass sources and bioconversion processes and products, and panel presentations and comments on bioconversion, including technology assessment, economic/social impacts, environmental impacts, and international aspects, are compiled. Separate abstracts were prepared for ERA for 45 items; 18 of the abstracts are included in EAPA. (JSR)

24151 **Ecology of bioconversion.** Peterson, R.W. (Council on Environmental Quality, Washington, DC). pp 61-71 of In Capturing the sun through bioconversion. Washington, DC; Washington Center (1976).

From Conference on capturing the sun through bioconversion; Washington, District of Columbia, United States of America (USA) (10 Mar 1976).

See CONF-760354—.

After a description of the ecological degradation occurring both in the industrialized areas of the world and in the least industrialized areas of the world, it is suggested that biogasification of animal and crop residues and municipal wastes by anaerobic fermentation might be a partial answer to the needs of both areas. (JSR)

ALCOHOL FUELS

REFER ALSO TO CITATION(S) 24999

PROPERTIES

REFER ALSO TO CITATION(S) 25003

PREPARATION

CHEMICAL SYNTHESIS

24152 (PERC—0060-5) **Sulfur poisoning of catalysts. Quarterly progress report, 1 July—30 September 1976.** Isakson, W.E.; Sancier, K.M.; Wise, H.; Wood, B.J. (Stanford Research Inst., Menlo Park, Calif. (USA)). 1 Nov 1976. Contract EY-76-C-02-0060. 68p. Dep. NTIS $4.50.

This study concerns the deactivation of catalysts used to produce fuels from CO and H_2O. The first phase of this research emphasized S poisoning of methanol-synthesis catalysts. During this reporting period an examination has been started of the role of C in Fischer-Tropsch catalysts. A discussion is presented of surface sulfidation and segregation with methanol-synthesis catalysts and the kinetics of C formation on Fischer-Tropsch catalysts. The thermodynamics and surface structures of S chemisorbed on transition metals are reviewed in the Appendix. Several iron-based Fisher-Tropsch catalysts were examined during reduction and carburization by thermogravimetric (TGA) and thermomagnetic (TMA) analyses. Catalyst B6 was reduced in H_2 and carburized in $H_2/CO = 3$ at atmospheric pressure. The results indicate that the fresh catalyst contains 77 wt% γ-Fe_3O_4, the remainder is α-Fe, promoters, and possibly, some carbidic compounds. Carburization carried out under temperature programming conditions in the range of 175 to 324°C results in the formation of Hagg carbide, Fe_5C, as the only ferromagnetic phase. Carburizations performed isothermally indicate the formation of: Hagg carbide at 300 and 224°C, a mixture of Hagg and hexagonal Fe_2C at 250°C, and hexagonal Fe_2C at 200°C. Formation of a precursor carbide is suggested during early stages of carburization at 324°C. The TGA results indicate the existence of two successive diffusion-limited carburization rates. From the temperature dependence of these two rates processes, the isothermal work of diffusion was calculated to be 9.5 and 6.5 kcal mol^{-1}.

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 24148, 24150, 24179

24153 (TID—27336) **Systems study of fuels from sugarcane, sweet sorghum, sugar beets, and corn. Fourth quarterly report.** Lipinsky, E.S.; McClure, T.A.; Sheppard, W.J.; Otis, J.L.; Lawhon, W.T.; Nathan, R.A. (Battelle Columbus Labs., Ohio (USA)). 30 Jun 1976. Contract W-7405-ENG-92. 95p. Dep. NTIS $5.00.

Preliminary results are presented of an economic analysis of the agricultural and conversion aspects of producing fuel and ammonia from sugar beets, sweet sorghum, and corn. Ethanol would by produced by fermentation of cane juice and methanol and ammonia from the synthesis gas obtained from the partial oxidation of the combustible organics using the Purox Process. (JSR)

PROPERTIES

24154 (UCRL-Trans—11186) **Electrochemical theory of catalysis in metals.** Merenkov, P.T.; Nabiev, M.N.; Merenkov, A.P. Translated from *Uzb. Khim. Zh.;* No. 1, 15-18(1976). 9p. Dep. NTIS $3.50.

Previous thermodynamic calculations of the emf for NH_3 synthesis in the N_2—H_2 combustion unit were experimentally verified with the combustion taking place over an iron oxide substrate. The solid electrolyte used was a disc of asbestos paper fiber glass impregnated with KOH. The combustion took place at atmospheric pressure and a temperature of 500°. The emf was measured, the volt-ampere curve was plotted, and the ammonia found in the nitrogen was determined. The current density for the electrodes of the catalytic microcombustion units was calculated in accordance with the theoretical principles of the electrochemical theory of catalysis in metals. (JSR)

PREPARATION

REFER ALSO TO CITATION(S) 24153

SOLID WASTE FUELS

REFER ALSO TO CITATION(S) 24148, 24179

24155 **Long-range concepts.** Valentine, R. (Univ. of California, Davis). pp 625 of In Capturing the sun through bioconversion. Washington, DC; Washington Center (1976).

From Conference on capturing the sun through bioconversion; Washington, District of Columbia, United States of America (USA) (10 Mar 1976).

See CONF-760354—.

The factors limiting conversion efficiency in plants, the possible achievable efficiency, and the conditions necessary to achieve this efficiency are discussed. Then a concept of controlled-environment agriculture (plastic greenhouse in the desert) for production of protein and energy is described. (JSR)

HYDRO ENERGY

RESOURCES AND AVAILABILITY

REFER ALSO TO CITATION(S) 24239, 24935

ENVIRONMENTAL ASPECTS

24156 (LBL—5296) **Environmental effects of hydroelectric power development.** Jassby, A.D. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1976. Contract W-7405-ENG-48. 27p. Dep. NTIS $4.00.

Problems in assessment of the environmental effects of hydroelectric power development are discussed. It is out that each hydroelectric development is unique. The construction of reservoirs change the patterns and extent of human utilization of the project area. The problems of erosion, sewage disposal, fertilizer runoff, etc., ultimately make themselves felt in the water quality of the reservoir and downstream. These problems are similar to those accompanying any urbanization process, but their magnitude is impossible to estimate without a detailed study of the conditions unique to any hydroelectric development. As in the case of more direct effects of reservoir construction, each water system deserves its own specialized study of climatological, geological, and limnological conditions if any acceptable projections are to be made and proper mitigating procedures to be planned. Despite the difficulties of estimating even the direction of an effect, let alone its magnitude, following reservoir construction, this outline does make one fact clear. Reservoir formation entails largescale ecological changes, many of them undesirable. Although generation of hydroelectric power produced no immediate pollutants, the indirect effects on water quality, surface geology, health hazards, and aesthetic appeal weigh heavily against its unrestricted expansion. In addition, long-term climatic changes make it difficult to forecast catchment area precipitation and subsequent power generation capacity of any given site. The notion that hydroelectric power is a "clean" and dependable alternative to other, more obviously polluting energy sources is not a viable one.

SOLAR ENERGY

RESOURCES AND AVAILABILITY

24157 (CONF-760842—15) **Calculation of monthly average insolation on tilted surfaces.** Klein, S.A. (Wisconsin Univ., Madison (USA). Solar Energy Lab.). 1976. Contract EY-76-S-02-2588. 14p. Dep. NTIS $3.50.

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.,; Winnipeg, Manitoba, Canada (15 Aug 1976).

Several simplified design procedures for solar energy systems require monthly average meteorological data. Monthly average daily totals of the solar radiation incident on a horizontal surface are available. However, radiation data on tilted surfaces, required by the design procedures, are generally not available. A simple method of estimating the average daily radiation for each calendar month on

surfaces facing directly towards the equator has been presented by Liu and Jordan. This method is verified with experimental measurements and extended to allow calculation of monthly average radiation on surfaces of a wide range of orientations. The results are presented in analytic and in tabular form for latitudes ranging from 25° to 55°, surface azimuth angles of +-45°, and for collector slopes within the range of practical interest.

24158 (ERDA/NASA/31293—76/3) **Listing of solar radiation measuring equipment and glossary.** Carter, E.A.; Greenbaum, S.A.; Patel, A.M. (Alabama Univ., Huntsville (USA). Center for Environmental and Energy Studies). Jul 1976. Contract NAS-8-31293. 54p. Dep. NTIS $4.50.

One immediate need for researchers and other users of solar energy conversion equipment is to select proper instruments for measuring solar radiation. Hence it is the intent of this report to serve as a reference guide so the user can compare performance, accuracy, and cost of equipment presently on the market based on the data provided by the manufacturer. It also provides relevant terms and diagrams for the prospective user of solar radiation instruments. (WDM)

24159 (LBL—5292) **Results from circumsolar radiation measurements.** Grether, D.F.; Hunt, A.; Wahlig, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1976. Contract W-7405-ENG-48. 8p. (CONF-760842—18). Dep. NTIS $3.50.

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc..; Winnipeg, Manitoba, Canada (15 Aug 1976).

Circumsolar radiation results from small-angle scattering of direct sunlight from atmospheric aerosols with dimensions on the order of, or greater than the wavelength of light. We have developed an instrument to provide measurements of circumsolar radiation as a function of angular distance from the sun and wavelength, for various atmospheric conditions, geographic locations, and times of year. These measurements are necessary to predict accurately the performance of solar thermal conversion systems using focusing collectors, and to determine whether pyrheliometer data are adequate for estimating this performance. Sample data are presented for two geographic locations.

24160 (NP—21393, pp 2-13) **Calculation of incident solar radiation.** Lawaetz, H. Jun 1976. (In Danish).

In Solar energy, June 1976.

Formulas are given for the calculation of the direct radiation, diffuse sky radiation, and diffuse reflected radiation. (JSR)

24161 **For the advancement of solar technology: the German Association for Solar Energy has been founded.** Urbanek, A. *Sanit. Heizungstech.;* 40: No. 11, 633(1975). (In German).

On 17th October 1975, the German Association for Solar Energy [DGS] was founded in Munich by a circle of scientists, artisans, and journalists who had been active for several months. The DGS thought that it was an ideal union for the advancement of solar energy utilization and for the speedy introduction of solar technology in the Federal Republic of Germany. The purpose of the association is to promote the exchange of knowledge between science, industry, departments of sanitation and heating, architects and building contractors, as well as all the private individuals and groups interested in solar technology.

24162 **Large test plant for the utilisation of solar energy.** *Wasser, Luft Betr.;* 20: No. 10, 528-529(Oct 1976). (In German).

3 figs.

A test plant for the utilization of solar energy in low-temperature-spheres with funds of the Federal Ministry of Technology and Messrs. Energietechnik GmbH, Essen, constructed in Wiehl, a climatic resort. This plant is thought to be the largest in Europe. The plant, its technical equipment, and the conceptions of energy supply are introduced and the aim and programme of the technical and scientific examinations are referred to.

HEAT STORAGE AND REJECTION

REFER ALSO TO CITATION(S) 24191, 24193

24163 (AI-ERDA—13176) **Experimental test of gas heat transfer system for hydroxide heat storage.** Ervin, G. (Atomics International Div., Canoga Park, Calif. (USA)). 29 Oct 1976. Contract E(04-3)-0701. 23p. Dep. NTIS $3.50.

In the development of a heat storage system based on inorganic hydroxide—oxide chemical transitions, the method of transferring heat into and out of the hydroxide storage material is of prime importance. This report presents the results of a series of tests using circulating gas as a means of heat transfer. On the basis of these results, it is concluded that circulating gas is a technically feasible concept, using steam as heat transfer fluid and using the chemical in the form of a fixed bed of porous granules.

24164 (AI-ERDA—13178) **Hydration-dehydration cycling of MgO—$Mg(OH)_2$ for application to solar heat storage systems.** Ervin, G. (Atomics International Div., Canoga Park, Calif. (USA)). 30 Sep 1976. Contract E(04-3)-0701. 19p. Dep. NTIS $3.50.

A method for storing heat energy by utilizing reversible chemical reactions of inorganic oxides with water is under investigation at Atomics International. The system design requires a knowledge of rates of the dehydration and hydration reactions, and, in order that these rates be significant for practical applications, it must be shown that these rates are maintained as the material is cycled repeatedly through the anhydrous and hydrated condition. For solar heat storage operating on a daily cycle, for example, a 3-yr life requires somewhat more than 1000 cycles. Besides the effect of cycling on reaction kinetics, the extent of corrosion by the inorganic oxide/hydroxide on its containment vessel during cycling is an important parameter. Also, since one form of the active material that appears to have some advantages is that of granules held together by an inorganic cement, it is important in this case to know if the granules are broken down by cycling.

24165 (NP—21393, pp 48-60) **Heat storage in eutectic salts.** Svendsen, S. Jun 1976. (In Danish).

In Solar energy, June 1976.

The use of salt hydrates for heat storage is discussed under the following aspects: characteristics of salt hydrates, selection of the hydrates, problems connected with their use for heat storage, possible solutions, and economic considerations. (JSR)

ECONOMICS

24166 (NP—21255) **Solar energy as a contribution to the energy crisis.** Tabor, H.Z. (National Physical Lab. of Israel, Jerusalem). 1973. 23p. Dep. NTIS (US Sales Only) $3.50.

The fact that the sun is the primary source of energy used on earth has created the impression in some quarters that solar energy is the answer to the energy shortage. It is the purpose of this paper to put the matter into proper perspective, to see clearly the difficulties and to determine to what extent and over what time scale solar radiation can contribute to our usable energy sources. Very long-term projections running into the next century and based upon a continuing growth rate in the world's energy consumption have suggested that finally the sun will be the major source of energy. But we are concerned with the next decade--or at most the remainder of the twentieth century--when, as will be seen, solar energy can be expected to contribute only a part--but perhaps a significant part--of our energy needs. (WDM)

SOLAR ENERGY CONVERSION

REFER ALSO TO CITATION(S) 24145

24167 **Solar energy conversion by water photodissociation.** Balzoni, V. (Univ., Bologna); Gleria, M. *Science;* 189: No. 4206, 852-856(12 Sep 1975).

A review showed that transition metal complexes are, in principle, suitable catalysts for closed-cycle hydrogen generation processes based on endothermic photochemical reactions. The most interesting cycles are those involving metal hydride complexes or binuclear complexes in which the two metal atoms are bound into a macrocyclic ligand. The review also covers the requirements of a cycle; direct photodissociation; and simple chemical cycles.

PHOTOVOLTAIC CONVERSION

REFER ALSO TO CITATION(S) 24173, 24174

24168 (ERDA/JPL/954355—76/11) **Large area silicon sheet by EFG. Annual progress report, October 29, 1975—September 30, 1976.** Morrison, A.D.; Ravi, K.V.; Hari Rao, C.V.; Surek, T.; Bliss, D.F.; Garone, L.C.; Hogencamp, R.W. (Mobil Tyco Solar Energy Corp., Waltham, Mass. (USA)). 15 Sep 1976. Contract NAS-7-100-954355. 117p. Dep. NTIS $5.50.

At the end of one year the program is on schedule. EFG ribbon growth system JPL No. 2 is being used to perform meaningful growth rate and ribbon thickness experiments. The new, wide ribbon growth system is in operation. A theoretical study of stresses in ribbons is reported. EFG ribbons have been observed to exhibit a characteristic defect structure which is orientation dependent in the early stages of growth.

24169 (ERDA/JPL/954527—76/2) **Investigation of test methods, material properties, and processes for solar cell encapsulants. Second quarterly progress report, August 12—November 12, 1976.** (DeBell and Richardson, Enfield, Conn. (USA)). Nov 1976. Contract NAS-7-100-954527. 44p. Dep. NTIS $4.00.

Potentially useful encapsulating materials for the Low Cost Silicon Solar Array project (LCSSAP) are being evaluated. Efforts

of the second quarter have involved the following studies: The inclusion of twenty-four potentially useful encapsulant materials into a program of accelerated aging and evaluation; tabulation and correlation of the changes in optical characteristics after 30 and 60 days of accelerated aging; tabulation and correlation of changes in mechanical properties after 30 and 60 days of accelerated aging; measurement of the effects of two months of soil accumulation; and continuation of an adhesion study involving the screening of commercially available primers, adhesives, and processes to bond candidate encapsulant materials to solar cells and substrates.

24170 (SAND—76-5311) **Silicon solar cell development for concentrated-sunlight, high-temperature applications.** Fossum, J.F.; Burgess, E.L. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1976. Contract E(29-1)-789. 7p. (CONF-761130—1). Dep. NTIS $3.50.

From 12. IEEE photovoltaic specialists conference; Baton Rouge, Louisiana, United States of America (USA) (15 Nov 1976).

The development of silicon solar cells for use in concentrated-sunlight, high-temperature environments, based on theory and experiment, is presented. The theoretical work is aided by exact numerical simulations of the cells. Suggested cell designs are then fabricated using standard integrated circuit processing techniques. The designs are verified through computer-controlled testing of the cells at solar illuminations up to 90 suns (9 W/cm^2) and temperatures up to 100°C. The development of a 5-cm-diameter silicon wafer cell for a 50-sun, approximately 100°C application is emphasized.

24171 (SAND—76-9142) **Effects of spectral variations on silicon cell output.** Boes, E.C.; Hall, I.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1976. Contract E(29-1)-789. 14p. (CONF-761129—1). Dep. NTIS $3.50.

From Terrestrial PV measurements workshop; Baton Rouge, Louisiana, United States of America (USA) (10 Nov 1976).

The performance of silicon solar cell at a specific location is usually predicted by multiplying the solar radiation incident at the site by the solar cell's "efficiency." This efficiency is specified as the ratio of the cell's output to the radiant energy input to the cell under specified conditions. It would be better to use a procedure which takes into account the fact that the performance of silicon solar cells depends upon the spectral distribution of the incoming energy. This is generally not possible because there are very few records of the spectral distribution of terrestrial solar radiation. One existing data source consists of spectral measurements of daily, total-horizontal radiation recorded by the Smithsonian Radiation Biology Laboratory at Rockville, Maryland. These data have been analyzed to determine the magnitude and character of the effects in silicon cell output resulting from real variations in the terrestrial solar spectrum. Results are reported.

24172 (UCRL—76203) **Temperature dependence of the photovoltaic performance of Si cells under blue, white, and near-bandgap irradiation.** Fischer-Colbrie, E.; Wichner, R.; Charlson, E.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.; Missouri Univ., Columbia (USA)). 3 Dec 1976. Contract W-7405-ENG-48. 7p. (CONF-761130—3). Dep. NTIS $3.50.

From 12. IEEE photovoltaic specialists conference; Baton Rouge, Louisiana, United States of America (USA) (15 Nov 1976).

The temperature dependence of V/sub oc/ and I/sub sc/ was investigated for various designs of solar cells under blue, white, and near-infrared illumination bands of equal photodensity thus producing carriers at different depths in the various cells. It was found that V/sub oc/ vs. temperature relation showed practically no dependence on the depth at which excitation occurred. Δ V/sub oc/ was about twice as large for non-homojunction cells than for homojunctions. The change in short circuit current with temperature, however, is sensitive to the depth at which carrier generation occurs. A decrease of I/sub sc/, with increasing temperature has been shown for excitation near the surface, a strong increase for excitation deep in the bulk with values for the white light showing an average of both.

24173 **Solar energy. Photovoltaics: photons in/electrons out.** *Mosaic;* 5: No. 2, 18-19(Spr 1974).

The economic outlook for photovoltaic generation of electricity is briefly considered. (WDM)

24174 **Japan's solar cell technology is moving ahead rapidly.** Tsuji, T. (Sharp Corp., Nara, Japan). *JEE (J. Electron. Eng.);* No. 114, 43-46(Jun 1976).

Japanese solar cells began to be used for terrestrial purposes in 1958 and have been used in quantity for powering lighthouses, telemetry systems, and unattended radio relay stations. The first use of Japanese solar cells in space as power sources for scientific satellites was made in 1971. The cells were used also in the ionosphere sounding satellite launched early this year. The Sunshine Project started by the Japanese Government in 1971 includes research on reducing the cost of photovoltaic cells by a factor of 100. Intensified efforts are thus being made to achieve a breakthrough in fabrication technology. In order to make low cost systems possible, development of new markets for existing devices is also being pursued.

24175 **Multilayer iron—thionine photogalvanic cell.** Hall, D.E. (Exxon Research and Engineering Co., Linden, NJ); Eckert, J.A.; Lichtin, N.N.; Wildes, P.D. *J. Electrochem. Soc.;* **123**: No. 11, 1705-1707(Nov 1976).

The iron—thionine photogalvanic system is being studied for the direct conversion of solar energy to electricity. This communication reports the development of such a cell with two transparent semiconductor electrodes, which allows the construction of multilayer devices for increased conversion efficiency. Each layer contains a SnO_2 anode and an indium tin oxide cathode. The thionine was contained in the solution. The output of a four-layer cell was measured, and the efficiency of the multilayer device is estimated. Monochromatic quantum efficiencies were measured for single-layer cells as a function of wavelength and cell thickness; results indicate that 25 μm solution layers would be more efficient than 80 μm layers. Several thiazine dyes other than thionine can be used; results are reported for a cell containing one layer of thionine solution and one layer of methylene blue solution. (DLC)

24176 **CdS—Cu_2 solar cells fabricated on Cd_2SnO_4—silica substrates.** Burton, L.C. (Univ. of Delaware, Newark); Hench, T.; Storti, G.; Haacke, G. *J. Electrochem. Soc.;* **123**: No. 11, 1741-1744(Nov 1976).

Cadmium stannate (Cd_2SnO_4) films of 1Ω per square sheet resistance and 85 percent average transmissivity (500 to 650 nm) were grown by means of rf sputtering onto silica substrates. CdS-Cu_2S thin film solar cells with conversion efficiencies greater than 5 percent for front and rear illumination were fabricated. The reflection of transmitted light back through the cell increased the light generated current. Fabrication techniques are described and current-voltage and spectral response measurements are presented for frontwall and backwall modes of operation. (7 figures)

PHOTOSYNTHETIC CONVERSION

REFER ALSO TO CITATION(S) 24150, 24151, 24153, 24155

24177 (SAND—76-5763) **Nonbiological photochemical energy conversion, can it compete.** Harrigan, R.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1976. Contract E(29-1)-789. 24p. (CONF-761135—1). Dep. NTIS $3.50.

From American Chemical Society Pacific conference; Phoenix, Arizona, United States of America (USA) (7 Nov 1976).

Solar photochemical energy conversion has much in common with solar thermal energy conversion systems. As a result, it is not to be expected that photochemical systems will be much less expensive than solar thermal systems. Since direct fuel production is unique to the photochemical system, the most promising application areas will be in those sectors such as transportation having particular needs for fuels. The results of an analysis of a combined photovoltaic/thermal system applied to meeting a community energy demand are reported.

24178 **Solar energy. Bioconversion: energy farming and recycling wastes for power.** *Mosaic;* 5: No. 2, 19-20(Spr 1974).

A quick look is taken at the "biomass plantation" concept and the conversion to methane of the organic portion of urban waste. (WDM)

24179 **Overview.** Quarles, J. (Environmental Protection Agency, Washington, DC). pp 39-47 of In Capturing the sun through bioconversion. Washington, DC; Washington Center (1976).

From Conference on capturing the sun through bioconversion; Washington, District of Columbia, United States of America (USA) (10 Mar 1976).

See CONF-760354—.

Diminishing fossil fuel resources and the growing dependence on foreign oil supplies necessitate energy conservation. Some areas in which this might be achieved are outlined, but conservation will not create new energy supplies. Development of alternatives to imported oil has detrimental environmental effects. These are briefly discussed for fossil and conventional nuclear energy, synthetic fuels from oil shale and coal, breeder reactors, geothermal energy, and offshore oil and gas recovery. The implementation of bioconversion, both to dispose of wastes while producing energy and to develop biomass for energy conversion, offers an alternative without many of the serious environmental problems associated with other energy sources. The environmental problems presented by this alternative must, however, be carefully evaluated. (JSR)

24180 **Statement at bioconversion conference.** Marvin, H. (ERDA Division of Solar Energy, Washington, DC). pp 73-79 of In Capturing the sun through bioconversion. Washington, DC; Washington Center (1976).

From Conference on capturing the sun through bioconversion; Washington, District of Columbia, United States of America (USA) (10 Mar 1976).

See CONF-760354—.

ERDA's role in the development of bioconversion processes is briefly outlined. The primary role will be one of cooperation with industry in research, development, and demonstration. (JSR)

24181 **Bioconversion: opportunities unlimited.** Domenici, P. (Senate, Washington, DC). pp 81-86 of In Capturing the sun through bioconversion. Washington, DC; Washington Center (1976).

From Conference on capturing the sun through bioconversion; Washington, District of Columbia, United States of America (USA) (10 Mar 1976).

See CONF-760354—.

The contribution that bioconversion can make to the total energy needs of the nation while dealing effectively with a serious pollution problem is outlined. The special benefits and advantages associated with the process are tabulated. (JSR)

24182 **Congressional perspective.** McCormack, M. (House Science and Technology, Washington, DC). pp 88-93 of In Capturing the sun through bioconversion. Washington, DC; Washington Center (1976).

From Conference on capturing the sun through bioconversion; Washington, District of Columbia, United States of America (USA) (10 Mar 1976).

See CONF-760354—.

The Congressional support given to research, development, and demonstration in the conversion of wastes to energy and fuels and the production of fuels from biomass is outlined. (JSR)

SOLAR THERMAL POWER PLANTS

24183 **Solar energy. Storage: making H while the sun shines.** *Mosaic;* 5: No. 2, 23(Spr 1974).

The production of hydrogen by solar and wind power plants as a means of energy storage is mentioned. (WDM)

ORBITAL POWER PLANTS

REFER ALSO TO CITATION(S) 24210

TOWER FOCUS POWER PLANTS

24184 (ERDA—76-159) **Solar Thermal Energy Conversion Program: summary report.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Solar Energy). Oct 1976. 79p. Dep. NTIS $5.00.

Project summaries are given for contracts pertaining to the central receiver power plant, 5 Mwth solar thermal test facility, total energy systems, distributed collector systems, hybrid systems, research and development, and program application and support. (WDM)

OCEAN THERMAL GRADIENT POWER PLANTS

24185 (NRL-MR—3392) **Geophysical fluid dynamics background for ocean thermal power plants.** Piacsek, S.A.; Toomre, J.; Roberts, G.O. (Naval Research Lab., Washington, D.C. (USA)). Oct 1976. Contract E(49-26)-1005. 77p. Dep. NTIS $5.00.

The vertical temperature gradient in the tropical oceans can be used to operate ocean thermal power plants (OTPP's) that function as heat engines. Such energy extraction would entail very large scale pumping of both warm surface water and cold bottom water through heat exchangers, with consequent disturbance and extensive mixing of surface and deep waters. The temperature difference between the warm and cold inflow of water should be maximized for plant efficiency, but entrainment and recirculation between the inflow and the outflow may reduce this temperature contrast. Further, horizontal currents and turbulence carry the outflow water to large distances and may produce significant changes. These flows are crucial in determining the thermal resource availability and the environmental impact of OTPP operation. This report provides background material and brief assessments in several areas of geophysical fluid dynamics (GFD) that bear directly on these problems. Relevant GFD research areas discussed include: turbulence and thermal wakes; ocean circulation and the permanent thermocline; air—sea interaction and thermocline variation; weather and climate modeling; and marine ecosystems. The report illustrates how each GFD area relates to specific OTPP problems, and emphasizes the multiple disciplines in GFD that must be considered.

24186 **Solar energy. Ocean/thermal: an unmixed blessing.** *Mosaic;* 5: No. 2, 22-23(Spr 1974).

The possibility of operating power plants on the temperature differences between warm surface water and frigid deep water is explored. (WDM)

SOLAR RADIATION UTILIZATION

24187 (CONF-760936—) **Solar energy and development.** 2 Oct 1976. Translation of French report. 19p. Dep. NTIS $3.50.

From Solar energy and development symposium; Bamako, Mali (28 Sep 1976).

A program to speed utilization of solar energy in the west African states is recommended. (WDM)

SPACE HEATING AND AIR CONDITIONING

REFER ALSO TO CITATION(S) 24973

24188 (ALO/3652—76/1) **Instrumentation of the New Mexico Department of Agriculture solar heated and cooled building. Progress report, September—November 1975.** San Martin, R.L. (New Mexico Univ., Albuquerque (USA). Dept. of Mechanical Engineering). Jun 1976. Contract E(29-2)-3652. 28p. Dep. NTIS $4.00.

This first of its kind solar heated and cooled building is being instrumented to evaluate its performance, and also to allow a comparison of solar system's actual performance versus predicted performance. A computer controlled data acquisition system, with appropriate sensors, is being developed to collect and process all performance evaluation data. Data collection system design was initiated along with the acquisition of some of the system components and data sensors. Collection of detailed information on each of the solar system components was also initiated. During the next reporting period the data collection system design will be finalized, along with the specification of the remaining data sensors and corresponding transducers. Building of the data system interface components will be initiated.

24189 (CONF-760842—9) **Review of solar cooling.** Duffie, J.A.; Beckman, W.A. (Wisconsin Univ., Madison (USA). Solar Energy Lab.). 1976. Contract EY-76-S-02-2588. 14p. Dep. NTIS $3.50.

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.,; Winnipeg, Manitoba, Canada (15 Aug 1976).

It is clear that there is a wide spectrum of potentially interesting methods for using solar energy for air conditioning, including many not mentioned in this brief review. Some of these have been extensively studied while some are still completely undeveloped. It is not clear at this time which of these various processes will find the widest application, or whether several of them will succeed in various climatic zones. The future of cooling is linked to component (collector and storage) development. It is also closely interrelated with developments in solar heating as the economics of the two processes appear to be better than that of either one alone.

24190 (CONF-760842—10) **Simulation study of solar heat pump systems.** Karman, V.D. Freeman, T.L.; Mitchell, J.W. (Wisconsin Univ., Madison (USA). Solar Energy Lab.). 1976. Contract EY-76-S-02-2588. 17p. Dep. NTIS $3.50.

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.,; Winnipeg, Manitoba, Canada (15 Aug 1976).

The performance of several configurations of solar-augmented heat pump systems are evaluated. These systems include both air and water collection systems with either air-air, water-air, or special hybrid heat pumps which can use both stored energy and ambient air as energy sources. The performance evaluations employ factorial design to determine the effect of the parameters of each individual system. The systems are compared with each other and with conventional solar and conventional heat pump systems. Simulations are done for Madison, Wisconsin; Albuquerque, New Mexico; and Charleston, South Carolina, to investigate climatological effects on solar heat pump performance. The results are used to formulate general guidelines for designing solar-augmented heat pump systems.

24191 (CONF-760842—11) **Performance of a solar heating system utilizing phase-change energy storage.** Morrison, D.J.; Abdel-Khalik, S.I. (Wisconsin Univ., Madison (USA). Solar Energy Lab.). 1976. Contract EY-76-S-02-2588. 15p. Dep. NTIS $3.50.

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.,; Winnipeg, Manitoba, Canada (15 Aug 1976).

A model describing the transient behavior of a phase-change energy storage (PCES) unit is presented. Simulation techniques are used in conjunction with this model to determine the performance of a solar air-heating system utilizing PCES. The effects of storage size and heat transfer characteristics on the system performance are investigated. Optimum ranges of storage sizes are given for systems with paraffin wax and sodium sulfate decahydrate as storage media. Comparison is made between two similar systems with sensible heat and phase-change storage. The variations of the collector efficiency and solar-supplied fraction of the load over the heating season are given for both systems. Actual weather data for the Madison area are used in these simulations.

24192 (CONF-760842—12) **Parametric study of critical fuel costs for solar heating in North America.** Duffie, J.A.; Beckman, W.A.; Brandemuehl, M.J. (Wisconsin Univ., Madison (USA). Solar Energy Lab.). 1976. Contract EY-76-S-02-2588. 13p. Dep. NTIS $3.50.

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.,; Winnipeg, Manitoba, Canada (15 Aug 1976).

Critical fuel energy cost, C/sub F/, is defined as the cost of delivered energy from conventional sources below which heat from optimized solar systems is more expensive than heat from conventional sources. The critical fuel energy cost is a useful index to assess the feasibility of solar heating in any location or region. A method is presented for estimating C/sub F/ for particular locations, buildings, solar collectors, and solar heating system costs. Tables are presented which permit determination of C/sub F/ as a function of system costs for 96 stations in the United States and Canada. Examples of C/sub F/ are shown for two of these stations.

24193 (CONF-760842—13) **Simulation study of several solar heating systems with offpeak auxiliary.** Hughes, P.J.; Beckman, W.A.; Duffie, J.A. (Wisconsin Univ., Madison (USA). Solar Energy Lab.). 1976. Contract EY-76-S-02-2588. 19p. Dep. NTIS $3.50.

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.,; Winnipeg, Manitoba, Canada (15 Aug 1976).

In essentially all climates, solar heating systems for buildings must incorporate back-up conventional (auxiliary) heating equipment sized to meet the maximum load of the building. In areas with high densities of solar heated buildings using auxiliary energy supplied by utilities, unacceptable peaks in auxiliary energy demand (during cloudy weather) can be prevented via limited on-site storage of the utility supplied energy. In this paper several "offpeak auxiliary" solar air heating systems are compared using simulation methods. Two basic types of offpeak systems have been studied; Systems I and II, which separate the storage of auxiliary and solar energy, and Systems III and IV, which store all energy in the same pebble bed. Simulation methods are used to determine the effect of system configuration, collector loss coefficient, controls, storage size, and collector flow rate on system performance.

24194 (COO—2588-1) **Modeling of solar heating and air conditioning. Progress report, October 31, 1974—December 31, 1975.** Duffie, J.A.; Beckman, W.A. (Wisconsin Univ., Madison (USA). Engineering Experiment Station). 31 Dec 1975. Contract E(11-1)-2588. 76p. Dep. NTIS $5.00.

The principal objective of the research is to develop the means to identify and optimize practical systems for heating and cooling of buildings with solar energy in the United States. This will be done through simulation methods. Secondary objectives are to: extend and refine TRNSYS (a modular solar energy system simulation program); develop the means of supporting TRNSYS users in other laboratories; use TRNSYS (and other simulation programs) to develop design procedures for solar heating and cooling processes; design and evaluate an experimental solar heating system on a Wisconsin farm residence.

24195 (COO/2577—76/1) **Design, construction, and testing of the Colorado State University Solar House I heating and cooling system. United States special format report.** Loef, G.O.G.; Ward, D.S. (Colorado State Univ., Fort Collins (USA). Solar Energy Applications Lab.). Jun 1976. Contract E(11-1)-2577. 122p. Dep. NTIS $5.50.

CCMS Solar Energy Pilot Study: solar heating and cooling systems in buildings.

The primary objective of the project is the design, construction, testing, and evaluation of a practical system for utilizing solar energy to drive heating, cooling, and domestic hot water subsystems, supplemented as necessary with auxiliary fuel. System design was accomplished during the first five months (September 1973 to January 1974) and construction completed during the following five month period (February to June 1974). This report details the evaluation of the system's performance during the period 1 September 1974 through 31 August 1975. Efforts are now underway to modify and improve the performance of the solar system, and conduct a comparative evaluation of the original design and the modified system. (WDM)

24196 (COO/2624—76/2) **United States special format report: Northview Junior High solar energy school heating augmentation experiment.** Merrill, G.; Dib, A. (Honeywell, Inc., Minneapolis, Minn. (USA). Systems and Research Center). Jun 1976. Contract E(11-1)-2624. 52p. Dep. NTIS $4.50.

The program described in this report demonstrates the ability of solar collectors to supplement the heating and hot water requirements of North View Junior High School in suburban Minneapolis. The program is obtaining engineering data which may be used to improve collector performance and system performance or design. In addition, data are being compiled which may be used to define investment requirements for similar installations. The program is also helping to determine community acceptance of solar heated school buildings. Construction was initiated during January 1974 and completed during May 1974. The basic rationale for the program is the necessity of obtaining firm answers in three areas: (1) validation of system performance, (2) determination of overall system costs, and (3) acquisition of data to determine the benefits of such a system. (WDM)

24197 (COO/2628—76/1) **Report of the George A. Towns Elementary School solar heating and cooling project, Atlanta, Georgia. United States special format report.** (Westinghouse Electric Corp., Baltimore, Md. (USA)). Jul 1976. Contract E(11-1)-2628. 105p. Dep. NTIS $5.50.

CCMS Solar Energy Pilot Study: solar heating and cooling systems in buildings.

The design, construction, and performance analysis of an experimental solar heating and cooling system to accommodate a building of approximately 3,000 m^2 in area are described. The objectives of the experiment are to: make a significant contribution to solar design, technology, and acceptability; conduct an advanced experiment on an integrated large-scale solar heating and cooling system, determine its performance, reliability, and maintainability, and compare these actual results with predicted performance; identify subsystem interface problems that cannot adequately be predicted by theoretical analysis; operationally test major components and identify improvements required; and identify cost reducing materials and techniques which may improve the economic viability of solar heating and cooling systems. (WDM)

24198 (NP—21393) **Solar energy, June 1976.** (Danmarks Tekniske Hoejskole, Copenhagen). Jun 1976. 89p. (In Danish and English). Dep. NTIS (US Sales Only) $5.00.

A collection of articles on solar space heating is presented. Separate abstracts were prepared for the individual articles. (WDM)

24199 (NP—21393, pp 26-33) **Calculations of a solar heating system.** Lawaetz, H. Jun 1976. (In Danish).

In Solar energy, June 1976.

The principles of the solar heating system considered are outlined and the heating requirements for three house types are evaluated. The calculation method used is summarized. The results of the economic calculations of a solar heated house are tabulated. (JSR)

24200 (NP—21393, pp 34-47) **Solar heating system with different sizes of accumulators.** Lawaetz, H. Jun 1976. (In Danish).

In Solar energy, June 1976.

The efficiency of the solar collector and the absorbed solar heat are calculated for different sizes of the accumulator for two houses with different heat needs. The results are tabulated. (JSR)

24201 (NP—21393, pp 61-75) **Dimensioning of the solar heating system in the zero energy house in Denmark.** Esbensen, T.V.; Korsgaard, V. Jun 1976.

From International solar energy congress; Los Angeles, CA ;USA: (28 Jul 1975).

In Solar energy, June 1976.

The house is designed and constructed in such a way that it can be heated all winter without any "artificial" energy supply, the main source being solar energy. With energy conservation arrangements, such as high-insulation (30 to 40 cm mineral wool), movable insulation for windows, and heat recovery in the waste water and ventilation systems, the total heat requirement for space heating is 2300 kWh per year. (WDM)

24202 (NP—21393, pp 76-88) **Solar houses in the United States.** Esbensen, T.V.; Svendsen, S.A. Jun 1976. (In Danish).

In Solar energy, June 1976.

Experimental solar houses in New Mexico, Colorado, Maryland, Washington, D.C., and Delaware are briefly described. (JSR)

24203 (NP—21427) **Solar heated greenhouse projects.** (Citizens for Energy Conservation and Solar Development, Inc., Los Angeles, Calif. (USA)). 30 Sep 1976. 13p. Citizens for Energy Conservation and Solar Development, Inc., Los Angeles, CA.

This is a progress report of experiments in the design, planning, and development of solar heated greenhouses. In these projects the sun is the principal source of heat. Temperature for plant growth is controlled primarily by passive and non-mechanical means as follows: reduction of heat losses by careful attention to good general insulation of the greenhouse; and in particular to doors, vents (when closed), and the ceiling; storage of heat in the earth, water, chemicals, rocks, or some combination of these elements. Heat may also be stored and made available to an attached greenhouse from a structure (mass) of another building, such as a home. The integral relationship of the home and the greenhouse helps to insulate the attached greenhouse against the nighttime loss of the sun's energy stored in the greenhouse in the daytime; use of moveable insulating panels as may be required for additional heat control; and, provisions

for sun control and natural ventilation to help reduce excessive heat in the greenhouse.

24204 Solar energy. Heating and cooling of buildings: sol's comfort package. *Mosaic;* 5: No. 2, 16-17(Spr 1974).

Solar heating and cooling of buildings are briefly discussed and NSF's efforts to move this concept into the public domain are mentioned. (WDM)

24205 Solar energy. Heating and cooling of buildings: step right up and take a look. *Mosaic;* 5: No. 2, 17-18(Spr 1974).

The four public schools utilizing solar energy for space conditioning are mentioned and the two-trailer mobile laboratory is briefly discussed. (WDM)

HEAT ENGINES

24206 (LBL—5293) **Nitinol engine development.** Banks, R.; Wahlig, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1976. Contract W-7405-ENG-48. 7p. (CONF-760842—17). Dep. NTIS $3.50.

From Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.,; Winnipeg, Manitoba, Canada (15 Aug 1976).

Unusual shape-change properties in a class of metals known as Shape Memory Alloys have been applied to the conversion of low temperature heat to mechanical work. A program for development of practical heat engines based on this phenomenon is underway, using the nickel—titanium alloy "55-Nitinol." Details of the current prototype engine design and results of preliminary testing are discussed in light of special considerations for using Nitinol in heat engines.

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 24157

24207 (CONF-7606126—1) **Design problems associated with the use of evacuated glass receivers for solar collectors.** Allen, J.W.; Schertz, W.W.; Levitz, N.M. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 18p. Dep. NTIS $3.50.

From 21. symposium of the American Scientific Glassblowers Society; Chicago, Illinois, United States of America (USA) (7 Jun 1976).

This paper deals with the problems associated with the design and construction of practical, low-cost collectors for solar energy systems. The design of evacuated receivers being used with a compound parabolic concentrator (CPC) is discussed, and means of minimizing optical and thermal losses are described. Emphasis is placed on the identification of problems that need attention by the glass industry. An evacuated receiver designed for use with a lightweight, thermoformed plastic 3x CPC is used as an example.

24208 (NP—21393, pp 14-17) **Some typical collector constructions.** Svendsen, S. Jun 1976. (In Danish).

In Solar energy, June 1976.

Illustrations are given of the basic construction of the most typical solar collectors. (JSR)

24209 (NP—21393, pp 18-25) **Calculations of a flat plate solar collector.** Kraegpoeth, K. Jun 1976. (In Danish).

In Solar energy, June 1976.

The yields of a flat plate solar collector are calculated and the results are given graphically and in tabular form. (JSR)

24210 (UCRL—52191) **Design and behavior of ribless solar reflectors.** Hyde, R.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Dec 1976. Contract W-7405-ENG-48. 297p. Dep. NTIS $9.25.

Thesis.

A thin, shallow, orbiting solar reflector can retain its shape without either being mounted on a rigid truss or by being spun. For orbits of synchronous or greater radius where solar radiation forces dominate, they can be made to keep the reflector in tension everywhere. In order to apply pointing torques to the reflector and to keep it in equilibrium as the gravity gradient forces and its attitude vary, it is necessary to have some active control over out-of-plane surface forces. This control is primarily achieved by varying the reflector's shape, which deviates from flatness by approximately less than 1 part in 100. Power from thin, low efficiency solar cells is used to control the thermal stresses in the reflector, and thus its shape. Large, approximately 5 km, diameter reflectors can remain in tension while operating in stable Sun-polar orbits, for half of the time they reflect sunlight to the Earth, while the rest of the time is devoted to attitude maneuvers to precess the orbital plane. Large scale use of these large, light, easy to deploy reflectors in the stable Sun-polar orbit will make it possible to augment the Earth's solar energy influx, and to control its climate.

24211 Improvements on heating and cooling systems using solar energy and thermal radiation. Gaudenzi, P. (to Zanussi S.p.A.). German(FRG) Patent 2,413,255/A/. 24 Jul 1975. 12p. (In German).

3 figs. Available from Dt. Patentamt, Muenchen (FRG).

A collector system is described which serves alternatively to absorb solar energy or to radiate surplus thermal energy into the atmosphere. The system consists of a flat plate collector in a box which can closed with a pivoting glas disk. When the disk is closed, the system functions as solar energy absorber. The heated liquid which flows through the collector evaporates and gives its energy into a second circulation by condensation in a heat exchanger. This second circulation serves for heating or hot water preparation. When the disk is open, the system functions as a radiator. In this case, heat energy is lead to the collector via a second heat exchanger and is radiated into the room.

GEOTHERMAL ENERGY

REFER ALSO TO CITATION(S) 24864

24212 Practical aspects of a viable geothermal energy program. McCabe, B.C. (Magma Power Co., Los Angeles); Aidlin, J.W.; Falk, H.W. Jr. pp 2045-2047 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Magma Power Company, which has now drilled more than 200 geothermal wells, pioneered today's U.S. geothermal operations by successfully completing a dry steam well at The Geysers in 1955. After drilling in many other areas, Magma concluded that all additional U.S. fields probably would involve hot brine; consequently it was essential to develop a binary-cycle process of generation. Patents for such a process, named "The Magmamax Power Process", were obtained by Magma in 1973. Magma's experience established that resources and technology are now available so that geothermal energy can make an earlier and more significant contribution to the U.S. goal of energy independence than any other prospect. Unfortunately, bureaucratic obstacles have unreasonably escalated costs and caused delays running into years. Magma proposes the following program to expedite production of electricity from geothermal sources: (1) erection and operation of at least one 10-MW and one 50-MW binary cycle plant (Magma is currently engineering such plants for construction); (2) simplified government regulations and environmental controls, both the concern of one agency, accompanied by favorable tax treatment; (3) prompt issuance of leases on federal lands in accord with the Congressional intent contained in the Leasing Act of 1970, and immediate implementation of the loan guarantee provisions contained in the Geothermal Energy Act of 1974; and (4) concentration of field efforts on drilling, pumping, and testing to prove the existence of viable fields, and of research on binary-cycle plant operation problems, all without illogical duplication. Acceleration of any program requires the cooperation, heretofore lacking, between this industry, government, and utility companies.

RESOURCE STATUS AND ASSESSMENT

24213 Geothermal energy. Taking mother earth's temperature. *Mosaic;* 5: No. 2, 24-25(Spr 1974).

The problems and possibilities of geothermal energy are reviewed. The four major types of geothermal resources—dry steam, wet steam, hot dry rock, and geopressured zones, are discussed separately. (MHR)

24214 Geothermal energy. Problems beneath the surface. *Mosaic;* 5: No. 2, 27-28(Spr 1974).

Problem areas where it is believed that new research is required are: drilling technology, reservoir engineering and management, extraction technology, power conversion, and environmental monitoring. Legal questions are mentioned briefly. (MHR)

24215 Proceedings of the second United Nations symposium on the development and use of geothermal resources held at San Francisco, California, May 20—29, 1975. Volume 1. Berkeley, CA; University of California (1976). 844p. (In several languages). (CONF-750525—P1). GPO.

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

The 299 papers in the Proceedings are presented in three volumes and are divided into twelve sections, each section dealing

with a different aspect of geothermal energy. Rapporturs' summaries of the contents of each section are grouped together in Vol. 1 of the Proceedings; a separate abstract was prepared for each summary. Volume 1 also contains ninety-eight papers under the following section headings: present status of resources development; geology, hydrology, and geothermal systems; and geochemical techniques in exploration. Separate abstracts were prepared for ninety-seven papers. One paper was previously abstracted for ERA and appeared as CONF-750525—17. (LBS)

24216 Summary of Section I: present status of resources development. Muffler, L.J.P. (Geological Survey, Menlo Park, CA). pp xxxiii-xliv of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Vol. 1. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P1.

The first two years after the 1970 United Nations geothermal symposium in Pisa, Italy, saw a slow but steady growth in geothermal development and exploration, mainly based on decisions made in the late 1960s. This period was highlighted by the increase of electrical capacity at The Geysers, California, USA, from 78 megawatts electrical (MWe) in 1970 to 237 MWe by the end of 1972. This period also saw the beginning of construction at Cerro Prieto, Mexico, and the continued development of space-heating and agricultural systems in Iceland, the USSR, and Hungary. Geothermal exploration increased steadily from 1970 to 1972, with substantial efforts in Italy, Japan, Iceland, USA, Indonesia, the Philippines, and Mexico. In addition, the continuing efforts of the United Nations supported exploration in Chile, El Salvador, Ethiopia, Kenya, Nicaragua, and Turkey. Also during these years, an increasing popular and governmental awareness developed of the nature and possible importance of geothermal energy. The slow, steady increase in geothermal activity accelerated abruptly in 1973 when imported oil became difficult for many countries to obtain and petroleum prices rose sharply. Attention has been manifested in accelerated exploration, increased drilling, and marked expansion of geothermal research and development. The status of geothermal electricity generation in 1975 is shown. Geothermal exploration efforts are outlined.

24217 Present status of world geothermal development. pp 3-9 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Vol. 1. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P1.

Recent changes in the world energy situation are reviewed together with their effect on the course of development in the field of geothermal energy. An overview is given of the geothermal installations existing in various parts of the world categorized under the characteristics of the geothermal heat sources. The status of new projects which are in the planning, exploration, or exploitation phases in different countries is surveyed. In all, upwards of 50 countries have either commenced or are displaying interest in geothermal development in their territories. In many of these countries which lack significant deposits of fossil fuels, the use of geothermal energy as an alternative energy source is particularly attractive because of the opportunity it offers for making considerable savings in the foreign exchange required for the importation of fuel. The present rapid rate of development of geothermal energy resources has been accompanied by difficulties associated with shortages of both equipment and suitable expertise.

24218 Geothermal energy and its uses: technical, economic, environmental, and legal aspects. Banwell, C.J. (United Nations, New York). pp 2257-2267 of In Proceedings of the second United Nations symposium on the develoment and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Among the many so-called "new" sources of energy which have been proposed or tested as replacements for the conventional sources (fossil fuels and hydroelectric), geothermal energy is virtually unique as the only alternative which was already cost-competitive with these established sources before the sharp rise in petroleum prices which occurred in 1973. Taking into account the overall effect of petroleum prices on the fossil fuel market, and of the probable cost of increasing the production of fossil fuels from alternative sources, it appears probable that the cost of electrical energy generated from a typical geothermal field will now be roughly half that from any alternative, including nuclear energy. One effect of this cost margin will undoubtedly be to promote the development of geothermal energy from fields which formerly looked less promising. At the same time expanding use will lead to improved exploration and development methods which, in turn, will result in reduced costs. For the immediate future, it seems probable that geothermal energy will be more beneficial to certain developing countries than to the industrial world. This is because geothermal energy can be developed economically in relatively small packages, ranging from 10 to 100 MW. In this way, the financial burden of heavy initial capital investment can be avoided, and later growth in demand can be met by plant extensions. For countries with limited indigenous fuel sources, the savings in fuel import costs can also become very significant. Thus, with fuel oil at $10 per barrel, the annual saving in fuel cost by substituting geothermal power would be over $7 million for each 50 MW of net capacity.

USA

24219 Geothermal energy. Starting to tap the hot reservoirs. *Mosaic;* 5: No. 2, 26-27(Spr 1974).

Knowledge gained about potential geothermal resources from subsurface data already available is discussed. The geothermal potential of the Marysville, Montana area and the island of Hawaii is described. Types of experimental power plants under consideration are mentioned briefly. (MHR)

24220 History and development of geothermal resources in Imperial Valley. Werner, S.L.; White, C.R. Sacramento, CA; California Dept. of Water Resources (1973). 6p.

From 16. annual meeting of Association of Engineering Geologists; Hollywood, CA, USA (25 Oct 1973).

The history of the geothermal area of Imperial Valley is sketched briefly from the observation of early explorers in the 1850's to the present, with emphasis on the current status geothermal wells drilled since 1957. The uses made of the geothermal fluids are mentioned. (MHR)

24221 Analysis of the potential use of geopressured geothermal energy for power generation. Wilson, J.S. (Dow Chemical, Freeport, TX); Shepherd, B.P.; Kaufman, S. pp 1865-1869 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

The deep geopressured hot brines found in the geosynclinal basin of the northern Gulf of Mexico are shown to be a potential source of geothermal energy for the generation of electric power. Two typical reservoirs were selected for production calculations. Results indicated water yields sufficient to power a 25-MW plant for 20 yr in one reservoir and a 60-MW plant in a second. Reservoir sizes were based on the assumption that known sands are bounded by existing fault systems. Sand thickness, permeability, and porosity were taken from oil-well data. A water temperature of 196°C at a depth of 4500 to 5600 m was obtained from well logs in the area. A flow rate of 51,000 barrels of brine per day was assumed from a 17.8-cm-diameter well casing. Economics of power production are calculated using an isobutane secondary cycle, a single-stage flash system, and a dual-stage flash. Maximum power was obtained from the secondary cycle, but a dual flash gave 97 percent equivalent power at a cost of 26.8 mil/kWh compared to 33.3 mil/kWh for the secondary cycle. Both calculations assumed credit for 0.85 m^3 of natural gas per barrel of water since considerable evidence exists that these waters will be near saturation with natural gas at their existing pressures and temperatures. It is concluded that a considerable potential, possibly as much as 40,000 MW of power, exists along the Texas Gulf coast. However, the high ratio of risk to reward precludes private development. The size of the potential and the interest to the public appear to justify expenditure of government funds to investigate this resource.

24222 Potential power generation and gas production from Gulf Coast geopressured reservoirs. House, P.A.; Johnson, P.M.; Towse, D.F. (Univ. of California, Livermore). pp 2001-2006 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Extensive on-shore and off-shore zones of geopressured water reservoirs are found in the Texas and Louisiana Gulf Coast region. Energy in these reservoirs is present in the form of natural gas in solution, thermal energy, and hydraulic energy. Reservoir depths generally vary from 5000 to 20,000 ft with corresponding temperatures from below 200 to above 300°F. Natural gas is presumed to exist at saturation levels in the reservoirs. Total flow, flashed steam, and binary cycle thermal energy conversion systems were investigat-

ed as a means to utilize the thermal energy. The total flow system was selected for a detailed power plant systems analysis. Power plant net power output was determined for both surface and injection disposal of the waste water. The range of electrical and gas output from 7-in. nominal production wells is from 0.36 megawatts (MW) and 6.4 standard cubic feet per second (scf/sec) to 6.2 MW and 39.9 scf/sec. The lowest values are for the shallow reservoirs with fluid disposal by injection and the higher values are for the deepest reservoirs with surface disposal. The shallow reservoirs would not be profitable for combined gas production and electrical power generation, but might be profitable for gas production alone. Deeper reservoirs would be profitable for combined gas production and power generation. The class of deepest reservoirs, without the presence of gas, would be marginally profitable for electrical generation alone.

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

REFER ALSO TO CITATION(S) 24215

24223 Summary of Section II: geology, hydrology, and geothermal systems. Muffler, L.J.P. (Geological Survey, Menlo Park, CA). pp xlv-lii of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Vol. 1. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P1.

The ideas and the data presented at the Second United Nations Symposium on the Development and Use of Geothermal Resources with respect to geology and hydrology of geothermal systems are summarized. No attempt is made to deal with mathematical models or reservoir engineering. The discussion of geothermal geology and hydrology has three goals: (1) to outline generally accepted models, (2) to highlight areas of agreement, controversy, or uncertainty and (3) to direct the reader to significant original references, both papers submitted to the Second UN Geothermal Symposium and recent papers published elsewhere.

24224 Dry steam possibilities in Saraykoy—Kizildere Geothermal Field, Turkey. Tezcan, A.K. (Maden Tetkik ve Arama Enstitusu, Ankara). pp 1805-1813 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

A geothermal field model has been put forward. In this model, under the considered topographic, reservoir, pressure, and temperature conditions, by using the relationship of boiling point to depth, it is shown that a steam cap can form. The model also helps to visualize how a well produces dry steam, a steam-water mixture, or no output. The following facts, considered in the model, are known to exist in Saraykaoy-Kizildere geothermal field: the shape of the reservoir and its depth have been determined from resistivity, geothermal gradient surveys, and drilling, and observations in the drill holes have shown that the hot water in the reservoir has a constant temperature and a constant hydrostatic level. Finally, for one of the topographic and reservoir sections, the water-steam separation level has been determined, and it shows that the reservoir should have a steam cap. The temperature measurements made in the only existing dry hole in this locality support this conclusion. Further drilling in the vicinity can produce dry steam and make possible the exploitation of the field as a dry-steam field.

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

REFER ALSO TO CITATION(S) 24234

24225 Recent studies of the Ahuachapan Geothermal Field. Vides, A. (Consultora Tecnica S.A., San Salvador, El Salvador). pp 1851-1854 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Recent geological, geophysical, and geochemical studies indicate that the Ahuachapan-Chipilapa-El Salitre area is a single geothermal area. Furthermore, it is probable that this area is connected with the Los Toles-Guayapa-El Durazneno geothermal field. Drilling activity has continued with the construction of new exploration, thermal gradient, and production wells. In addition, Wells Ah-5 and Ah-7 were reworked, increasing their production. Different methods of waste water disposal are compared. Since the construction of a discharge canal to the sea is delaying the entire project, reinjection tests were restarted. A reinjection program is proposed which could solve the waste water disposal problem at a small cost.

GEOPHYSICAL TECHNIQUES AND SURVEYS

24226 Preliminary findings of an investigation of the dunes thermal anomaly, Imperial Valley, California. Coplen, T.B.; Combs, J.; Elders, W.A.; Rex, R.W.; Burckhalter, G.; Laird, R. Sacramento, CA; California Dept. of Water Resources (1973). 52p.

During the drilling of the Department of Water Resources DWR Dunes No. 1, about 100 meters of core was recovered and water samples from three different depths were collected. In addition, geophysical logs were run. Temperature gradient surveys were conducted during drilling. Subsequent to drilling, preliminary chemical and isotopic investigations were made of the water samples, x-ray diffraction studies of the clays, and petrologic and physical properties investigations of the core. Preliminary results of studies of this test hole are reported. (MHR)

24227 Summary of Sect'on IV: geophysical techniques in exploration. Combs, J. (Univ. of Texas, Dallas). pp lxxxi-lxxxvi of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Vol. 1. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P1.

Geophysical exploration involves the study and measurement of physical waves, fields, and emissions of the solid earth and the interpretation of these observations in terms of realistic geological models. The role of geophysics in the exploration for geothermal resources has been examined and discussed in several review papers. Geophysics applied to the exploration for, and delineation of, geothermal resources spans a wide range of subject areas from the measurement of physical parameters of rocks to development of instrumentation and measurement systems to data acquisition and digital data processing and to the modeling and geological interpretation of geophysical data. A considerable volume of geophysical data pertaining to geothermal systems has been developed since the first United Nations Symposium on the Development and Utilization of Geothermal Resources held in Pisa, Italy, in 1970. In addition to refinements and increases in the effectiveness of existing geophysical exploration systems, some methods and techniques not previously used in geothermal exploration have been adopted from crustal geophysical studies as well as from the petroleum and mining industries, for example: teleseismic P-wave delays, tellurics, self-potential-SP, audiomagnetotellurics-AMT, and have been given thorough field tests. Several well-documented geothermal case histories have either been completed through the exploratory drilling phase or are presented as progress reports. The intent of this summary is to clarify several concepts associated with geophysical exploration, to emphasize the need for realistic geological models that can be tested, to summarize the diversity of geophysical information presented, and to direct the reader to significant papers published elsewhere.

24228 Geothermal energy in North Sea might extend platform usefulness. *Ocean Ind.;* **11**: No. 9, 270(Sep 1976).

The North Sea is one area to be studied for geothermal energy potential by Britain's Department of Energy. A relatively well documented area shows some of the highest temperature gradients recorded in the UK. Fairly extensive regions are known to have gradients over 40°C/km and as these tend to correlate with deep sections of the sedimentary basin there are good prospects for obtaining heat in the range 150--200°C. The temperature at the bottom of one hole drilled for oil topped 160°C. It is suggested that heat recovered from hot rocks or hot aquifers might cost less at the well-head than low-temperature heat from imported oil. It estimates that the heat beneath each square kilometer of hot rock could be recoverable at a rate equivalent to 200,000--300,000 tons/year of coal for 20 years, while hot aquifers might yield heat equivalent to 50,000 tons/year of coal per sq km over the same period. (MCW)

GEOCHEMICAL TECHNIQUES AND SURVEYS

REFER ALSO TO CITATION(S) 24215, 24226, 24236

24229 Summary of Section III: geochemical techniques in exploration. Truesdell, A.H. (Geological Survey, Menlo Park, CA). pp liii-lxxix of In Proceedings of the second United Nations symposium

on the development and use of geothermal resources. Vol. 1. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P1.

Geothermal fluid chemistry finds its widest application in exploration, and it is this aspect that is stressed. Recent exploration activities have resulted in new chemical data on thermal fluids from springs and wells in Afars and Issas, Canada, Chile, Columbia, Czechoslovakia, El Salvador, Ethiopia, France, Greece, Guadeloupe, Hungary, Iceland, India, Indonesia, Israel, Italy, Japan, Kenya, Mexico, New Britain, New Zealand, the Philippines, Poland, the Red Sea, Rhodesia, Swaziland, Switzerland, Taiwan, Turkey, the United States, the USSR, and Yugoslavia. New methods for estimating subsurface temperatures have been proposed based on chemical and isotopic analyses of surface and well discharges. Chemical indices based on trace constituents of spring fluids and deposits, altered rocks, soils, and soil gases have been proposed as aids to geothermal exploration. Chemical models of interaction of geothermal fluids with reservoir rocks have been constructed. Studies of alteration in geothermal systems have aided exploration and exploitation. Finally, studies of geothermal rare gases suggest that although most are atmospheric in origin, excess ^3He in some systems may come from the Earth's mantle.

EXPLORATORY DRILLING AND WELL LOGGING

REFER ALSO TO CITATION(S) 24226

LEGAL AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 24218

24230 Summary of Section XII: legal and institutional aspects. Anderson, D.N. (State Energy Commission, Sacramento, CA). pp cxxix-cxxxii of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Vol. 1. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P1.

In general the papers in this section dealing with legal and institutional matters covered the more important aspects of the subjects. The history of geothermal law in New Zealand, Iceland, Japan, and the United States is presented and compared. Without doubt geothermal legal and institutional problems are universal in nature; however, some countries are more advanced than others in their solutions to the problems. In addition, numerous peripheral problems are included, such as: water law, definition of the resource, geothermal rights, and preservation of unique geothermal hot springs areas. Some of the papers deal with economic and forecasting models.

24231 Multipurpose geothermal resource development: an overview. Barnea, J. (United Nations Inst. for Training and Research, New York). pp 2197-2200 of In Proceedings of the second United Nations symposium on the develoment and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Three interrelated complexes determine the possible multipurpose utilization of a geothermal resource, namely (1) the resource conditions, (2) the regional economic conditions, and (3) the institutional conditions. The resource conditions may allow hundreds of different resource combinations for multipurpose utilization. These will depend on the type and size of the resource and its temperature; its water and mineral and gas content; its balneological potential; and nearby related resources as well. A variety of possible resource combinations are discussed. The regional economic conditions are overriding for resource utilization as most geothermal resources require local utilization. Detailed discussions lead to the conclusion that developed areas with agriculture, industries, and cities offer the best conditions, whereas rainy and sparsely populated tropical areas represent the most unfavorable economic conditions for multipurpose geothermal projects. Institutional conditions include government regulations at the state and local level; the attitude of geothermal developers such as governments, oil companies, and so on; environmental laws and attitudes; and institutions providing geothermal training and information. It is shown that in almost all cases of government-owned geothermal projects, the actual control is in the hands of government electricity corporations, explaining the electricity-only utilization of most developed geothermal resources. This attitude is shared by most oil companies, and it emerges as a main factor in the U.S. geothermal development. Wider resource information, more economic studies, and institutional improvements are proposed.

ECONOMIC AND FINANCIAL ASPECTS

REFER ALSO TO CITATION(S) 24218, 24221, 24222

24232 Summary of Section XI: economic and financial aspects. Barr, R.C. (Earth Power Corp., Tulsa, OK). pp cxxi-cxxviii of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Vol. 1. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P1.

Capital is a resource more scarce than oil, gas, coal, uranium, or geothermal energy. The marketplace, if permitted to function, and the efficient use of scarce capital will assure adequate supplies of energy in various forms to the common benefit of society as a whole. Geothermal energy for electrical power generation is viewed as competitive with conventional fuels as a source of energy. In order to substantiate this view, geothermal utilization must therefore be developed on a scale equivalent to millions of barrels of oil production per day. The data presented in these papers to describe the economics of geothermal energy are generally based on experience from activities in the United States. The economic parameters established for operations in the United States are most likely representative of the highest costs to be encountered because of regulatory and environmental constraints and therefore may be used for conservative world-wide economic analysis. World oil prices, the geothermal geologic setting, the means of converting geothermal energy into electricity, and the financial parameters associated with existing and planned additions to electrical generating capacity by the western United States utilities combine to make up the geothermal marketplace in this discussion.

24233 Geothermal energy and electrical power generation. Barr, R.C. (Earth Power Corp., Tulsa, OK). pp 1937-1941 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

The economics of electric power generation by means of fossil fuels and by means of geothermal energy are compared. This paper describes capital and fuel costs in some detail and touches on operating costs. Comparisons for nuclear fuels are not included due to the paucity of satisfactory data; capital costing for nuclear plants also does not lend itself to this comparison. Currently marginal or underdeveloped geothermal sources (such as hot dry rocks or low temperature, highly mineralized water) are not considered. Comparisons are restricted to oil, gas, coal, dry steam, and flashed steam—energy sources with which adequate experience has been gained—and also to binary cycles above a critical temperature. For comparison, the different sources are standardized according to British thermal units (Btu) per commodity unit of the energy source: coal, oil, gas, or geothermal fluid, assuming that the same amount of electricity (1 kWh) is generated for each 10,000 Btu regardless of source, assuming typical plant efficiencies. Data used are from The Geysers, Otake, and Cerro Prieto. Some conversions have been made to adjust the figures to a standard 110-MW generating unit, and to relate all costs to the same late-1973 level. For binary cycle possibilities, only reservoirs whose temperatures exceed 360°F (182°C) are considered commercial in this paper; the amount of hot water consumed per kWh increases markedly at lower temperatures. It is shown that under the conditions assumed, geothermal energy is commercially competitive and can reach profitable levels of operation.

24234 Geothermal exploration: strategy and budgeting. Barr, R.C. (Earth Power Corp., Tulsa, OK). pp 2269-2271 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

The goal of geothermal exploration is to find dry-steam or hot-water reservoirs. The margins of coastal plate boundaries, where the leakage of internal heat is most intense, are logical places in

which to begin identifying targets for exploration. Since dry-steam reservoirs may actually be mature hot-water systems heated by underlying reservoirs of dry steam, discoveries of dry-steam resources may be attained in strategic exploration more frequently than is currently supposed. Projections of relative abundances of reservoirs at different temperatures are discussed; it appears that an exploration program to find 1 dry steam field should begin with a minimum of 30 targets, but will involve the drilling of 4 deep wells. A strategy for exploration is outlined, along with an economical program and its projected costs. An adequate exploration program should have a budget of $6.0 million, including land-lease, evaluation, detailed geophysics studies, deep drilling and all associated costs. The drilling of four deep wells according to a carefully planned strategy should lead to at least one commercial discovery of geothermal energy.

ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL

24235 Summary of Section V: environmental factors and waste disposal. Armstead, H.C.H. (Rock House, South Devon, Eng.). pp lxxxvii-xciv of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Vol. 1. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P1.

The problems of environmental pollution are considered under the following subjects: hydrogen sulfide, carbon dioxide, land erosion, waterborne poisons, airborne poisons, noise, heat pollution, silica, subsidence, seismicity, escaping steam, scenery spoilation, and ecology. Reinjection is discussed at some length. (MHR)

BY-PRODUCTS

REFER ALSO TO CITATION(S) 24222

24236 Rare elements in thermal ground water. Balashov, L.S. (All-Union Scientific Research Inst. of Hydrogeology and Engineering Geology, Moscow). pp 2187-2195 of In Proceedings of the second United Nations symposium on the develoment and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

The utilization of thermal ground waters for energy purposes may prove to be more profitable when using these waters as a source of obtaining lithium, rubidium, cesium, boron, strontium, and so on. High concentrations of lithium, rubidium, cesium, and boron have been found in thermal carbon dioxide water of mountain-folded regions of the Alpine zone, in thermal water of the regions of recent volcanism, and in hot brines of artesian basins. High concentrations of strontium are characteristic only of artesian brines. Rare elements are accumulated mainly in chloride-sodium and chloride-calcium ground waters. Low values of the Na:Li, K:Rb, and K:Ca ratios are typical of rare-metal waters. These ratios may be an exploration index of thermal water. The problem of industrial extraction of rare elements from thermal water should be developed in the direction of (1) preparing a raw material base, that is, in finding thermal water and in calculating water resources; and (2) working out technological methods of extracting rare elements from thermal water in different geochemical classes.

24237 Development of industry based on geothermal energy, geothermal brine, and sea water in the Reykjanes Peninsula, Iceland. Lindal, B. (Virkir Consulting Group Ltd., Reykjavik). pp 2223-2228 of In Proceedings of the second United Nations symposium on the develoment and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Development work regarding the Sea Chemicals Complex, envisaged in the Reykjanes Peninsula in Iceland, is continuing. During 1970 to 1974 a drill hole of 1700 m freely discharged steam and brine to the atmosphere in the Reykjanes area. The change in flow rate proved to be moderate, and there was no change in chemical composition of the original fluid. A small pilot plant for concentration of the brine was operated in 1971. These experiments indicated that no pretreatment of the brine was necessary, and that it would be most suitable to separate the silica from the brine after concentration to saturation with respect to sodium chloride. An acceptable level of heat transfer was obtained in forced circulation evaporators. As a preparatory step for the final design of a 250,000-ton salt plant, a major pilot plant operation is being planned for 1975-1976. During 1970 to 1972 extensive experimental work was conducted on the production of magnesium chloride with the goal of producing metallic magnesium. The basic raw materials considered were sea water and geothermal salt. Soda ash would be a byproduct. Two processes were tested for the conversion of magnesium bicarbonate and salt into magnesium chloride and soda ash. Both appear to be technically and economically feasible if geothermal steam is used. Some considerations have also been given to other products in the Sea Chemicals Complex, such as caustic soda and chlorine. All process design and development is focused on the use of geothermal energy wherever this is useful.

GEOTHERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 24222, 24233, 24256, 24263, 24269

24238 Summary of Section VIII: electricity production. Armstead, H.C.H. (Rock House, South Devon, Eng.). pp ciii-cx of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Vol. 1. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P1.

Papers summarized in this section deal with power plant design and operation; new developments and ideas such as reinjection, two-phase fluid transmission, binary cycles, total flow prime mover; and other topics such as cost, computer applications, corrosion, and moderate temperature utilization.

24239 Some unusual ways of developing power from a geothermal field. Armstead, H.C.H. (Rock House, Dartmouth, Eng.). pp 1897-1904 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

The conventional way of generating power from a geothermal field is by means of condensing turbines supplying base load. Noncondensing plants (apart from their use as pilot and emergency plants and from their enforced use when generating base load from geothermal steam having a high gas content) could nevertheless be used economically, and to a limited extent, for supplying secondary peak loads, that is, low load-factor load "below" the extreme peak in the load duration curve. An unconventional but logical approach to cost analysis shows that exploration costs should be regarded as a variable, rather than as a fixed, component; and this conclusion supports the arguments in favor of using noncondensing plants for carrying secondary peak loads. With "wet" geothermal fields sited well above sea level, the water phase—preferably after as much heat as possible has first been extracted from it—may sometimes be able to contribute substantial by-product power by passing through conventional water turbines. This by-product power could be used for base load, peak loads, or even for augmented peak loads (pumped storage).

24240 Thermogravimetric pilot plant for the production of mechanical energy from low-enthalpy sources. Arosio, S. (Politecnico, Milan); Silvestri, M.; Sotgia, G.; Muzzio, A. pp 1915-1924 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

A preliminary study of a conversion system, the so-called "thermogravimetric" system, was presented at the First UN Symposium on the Development and Utilization of Geothermal Resources in 1970. The operation of the system is based on natural circulation obtained by injecting a vapor into the base of a closed vertical loop containing water and separating it at the top. This is done in such a way that in one branch of the circuit, a two-phase upward flow is produced while only the water flows downward in the other branch. The enthalpy drop of the expanding vapor, through the difference of specific weight of the two flows, is converted into hydraulic energy which can drive a turbine. When the vapor goes through a thermodynamic cycle, the system is capable of converting thermal energy into mechanical energy and is especially suited to the exploitation of

sources having a temperature not much higher than 100°C. Making use of the experimental data on two-phase flow into large ducts, the study evaluates the main dimensional and operating characteristics of a 1-MW plant taking into account the actual behavior of its components. The plant has a useful height of approximately 50 m, a duct diameter of approximately 2 m, and operates with a Freon 11 or 21 cycle having extreme temperatures of 70/30°C, maximal thermal efficiency of approximately 6 percent, and water consumption at 110°C of approximately 90 kg/sec. This paper shows the influence of the input parameters such as height of circuit, power, mass velocities, and so on, on diameters, volumes, efficiencies, water consumption, and so on, as well as a satisfactory off-design performance of the plant. Finally, the capital cost and the cost of the power produced are evaluated in a study now in progress.

24241 Development of a typical generating unit at the Geysers Geothermal Project: a case study. Dan, F.J.; Hersam, D.E.; Kho, S.K.; Krumland, L.R. (Pacific Gas and Electric Co., San Francisco). pp 1949-1958 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Since 1958 Pacific Gas and Electric Company (PG and E) and its steam suppliers have been developing the only commercial geothermal project for the production of electric power in the United States. Located at The Geysers in northern California, this project is the largest geothermal installation in the world. At present, 502,000 kW (net) of generating capacity have been placed in service and over 400,000 kW of new capacity are planned, but environmental, geographical, and resource utilization problems continue to challenge this project. Because the cost of electric power produced by geothermal energy compares favorably with that produced from other sources and because it is a secure, domestic energy source, it had been planned to install new capacity at The Geysers at a rate of about 100,000 kW/yr. However, changing environmental requirements and an air-emission problem requiring new technology have delayed this schedule. This paper describes the development of a typical new geothermal unit from project inception and planning, through engineering, construction, and start-up.

24242 Volcanic power plant with artificial fractured zone. Hayashida, T. (Nagasaki Univ.). pp 1997-2000 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Study of volcanic generation has just started in the last few years. It is too early to deal with plant design and performance of equipment, but the necessary information for the design of such a plant should be gathered from many sources. A full understanding of the subject requires the close cooperation of various specialists. The principal items discussed are: (1) how many factors affect each other, (2) proposed field experiment procedures to get necessary information for power engineering, (3) the specific characteristics and purpose of such a plant as part of a power system, and (4) the information needed from specialists in other fields.

24243 Exploitation of sea-floor geothermal resources: multiple-use concept. Palmer, H.D. (Westinghouse Ocean Research Lab., Annapolis, MD); Forns, J.M.; Green, J. pp 2241-2247 of In Proceedings of the second United Nations symposium on the develoment and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Inasmuch as the continental shelves of the world are largely drowned extensions of coastal geologic structure, there exist many offshore sites along projections of known geothermal activity which could be exploited by existing marine technology. This paper considers the concept of placing a geothermally powered electrical generating station on the sea floor at continental shelf depths (greater than 200 m). Power generated at this station would be transmitted via cable to shore. Alternatively, the heat could be employed in the thermal dissociation of water to hydrogen and oxygen, the former being stored as a compressed gas recoverable as a fuel for hydrogen-powered energy sources. The heat normally "discarded" to the environment after passing through turbines could be beneficially employed by circulating steam through a radiator embedded in shelf sediments. Condensate would be returned to depth as liquid to complete a closed cycle. The heated sea floor would become a preferred site for certain commercially valuable species of fish and crustacea. Current experiments in exploitation of heated effluent suggest that the yield of food resources can be increased to four to five times the normal annual production. Selection criteria for ranking 79 potential sites rated both the present and future geotechnical feasibility and socioeconomic potential. Three prime areas found to offer the greatest benefit for a sea-floor electrical generating plant and mariculture station are Soufriere Bay of St. Lucia, West Indies; southern Kagoshima Bay, Kyushu, Japan; and the Bay of Plenty, North Island, New Zealand.

DESIGN AND OPERATION

REFER ALSO TO CITATION(S) 24264, 24265

24244 Advanced design in Hatchobaru Geothermal Power Station. Aikawa, K. (Mitsubishi Heavy Industries, Ltd., Nagasaki); Soda, M. pp 1881-1888 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

The 50-MW Hatchobaru geothermal power station in Japan is now being constructed to be placed in service in 1977. This power station, which is a so-called double-flash-cycle geothermal plant, generates electricity, using not only the primary steam but also the secondary steam flashing from the primary hot water. The plant is designed to be efficient and economical with newly developed techniques such as a highly efficient flasher, a mixed-pressure turbine, a steam-water mixture transmission system, a condenser constructed with turbine foundation, an ejector-radial blower combined gas extraction system, and so on. Prior to the design of this power station, an experiment on a model flasher was carried out at the Otake geothermal field, and a flasher which is able to produce secondary steam of above 99.9 percent dryness was successfully developed as a result. As for the transmission of steam-water mixtures, tests were conducted at the Otake and Hatchobaru geothermal fields. These tests showed that there is no serious obstacle in steam-water mixture transmission through one pipe. A shop test of the new gas extraction system has proved that the steam consumption is half as much as that of the ordinary ejector system. The foundation of a turbine-generator was made hollow and lined inside with polyester resin for use as a condenser. The adoptation of such a condenser made the turbine floor height 5 m lower than usual, and the plant became more compact, since spaces under both the turbine and the generator can be used for the condenser.

24245 Power generation at Cerro Prieto geothermal field. Guiza L, J. (Comision Federa de Electricidad, Mexico City). pp 1976-1978 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

The Cerro Prieto geothermal field is of the water-dominated type. Wells drilled to an average depth of 1300 m produce a water-steam mixture in a weight ratio which varies from well to well from 0.5:1 to 4:1. Wells are cased with 298-mm and 196-mm diameter piping, with slotted casing at the bottom. Separated steam is utilized in a 75,000-kW power station, which has operated for about two years. Construction of a similar power station is underway to duplicate its capacity. Separation of the water-steam mixture is performed in cyclone Webre-type separators, which have demonstrated high efficiency as shown by the slight amount of deposits found on the turbine blades during inspection after one year of operation. Scaling of the wells has been experienced. Three low-output wells are now out of the line and about to undergo cleaning. Separated water is now being disposed of in an evaporation pond. Problems encountered have not been insurmountable. The operation of the plant is a great success. The total potential of the Cerro Prieto field is yet to be known. A new well drilled 1.5 km northwest of the area under exploitation to a depth of 2000 m has shown a bottom-hole temperature of 344°C and a maximum wellhead discharge pressure of 77 kg/cm^2(g).

24246 Conceptual design and cost estimate for a 10-MWe (net) generating unit and experimental facility using geothermal brine resources. Hankin, J.W.; Beaulaurier, L.O.; Comprelli, F.O. (Bechtel Corp., San Francisco). pp 1985-1996 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

A conceptual design and corresponding cost estimate were developed for a 10-MWe (net) generating unit and an experimental

facility. Typical site conditions at Heber, California, were used to develop and illustrate the concepts involved in the design. The experimental facility was designed to serve as a test-bed for developing advanced geothermal processes and equipment using geothermal fluid under field operating conditions. Laboratories, test equipment, and instrumentation were provided to meet the projected research and development needs for this type of resource over a wide range of experimental objectives. The energy conversion process of the 10-MWe (net) generating unit was based on a supercritical Rankine cycle using isobutane as the working fluid. The conceptual capital cost estimate and an engineering and construction schedule were developed from the engineering drawings, equipment lists, and data which delineate the conceptual design. Conceptual capital cost estimates were prepared for engineering and constructing the experimental facility and the generating unit as a combined facility, and also for each if undertaken separately.

24247 Geothermal operating experience, Geysers Power Plant. Matthew, P. (Pacific Gas and Electric Co., San Francisco). pp 2049-2054 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Fourteen years' operating experience at Pacific Gas and Electric Company's Geysers Power Plant has demonstrated that geothermal electric power generation can be reliable and economical. Location, terrain, environment, personnel considerations, and operating requirements created new and unique problems compared to traditional thermal power generating practices. Common interests and goals of the steam supplier and the power plant operator have helped in their solution. Much has been learned about the selection of equipment and materials.

24248 Geothermal plants in Italy: their evolution and problems. Villa, F.P. (Franco Tosi Co., Legnano, Italy). pp 2061-2064 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

The use of geothermal steam for power production started in Italy in 1894, in addition to the use of its heat for other purposes. The main plants in operation today are described. Recently it was decided to drive bigger gas compressors directly by the main turbogenerators, also for units of 30 MW. The main problems, including those for plants with wet steam are listed and discussed.

24249 Summary of thirty years' experience in selecting thermal cycles for geothermal power plants. Zancani, C.F.A. (ELC-Electroconsult, Milan). pp 2069-2074 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

The various thermal cycles which have been or are being adopted to exploit geothermal power are reviewed. Before 1946, the only geothermal fields exploited were those in Italy. Electric power production was coupled with the production of boric acid to concentrate solutions which had a content of 0.0002 of H_3BO_3. The secondary steam, free from noncondensable gases, was sent to the turbine. These cycles simplified the problems connected with elimination of the large quantity of noncondensable gases and with corrosion. Flow diagrams, efficiencies, and limits are examined for possible economical introduction in modern plants. After 1946, cycles with direct turbine inlet of geothermal steam were adopted, thanks to new corrosion-resistant materials and to progress in the construction of compressors for noncondensable gases. Wet and superheated steam cycles and the problems which are most likely to be encountered in the design of future power plants exploiting natural or artificial geothermal fields are examined.

POWER PLANT SYSTEMS AND COMPONENTS

24250 Basic design of a cheap wellhead noncondensing turbine. Armstead, H.C.H. (Rock House, Dartmouth, Eng.). pp 1905-1913 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

There is a need for a very cheap geothermal turbine which could be mounted at the wellhead to serve as a pilot plant for pioneering work, as an emergency unit, or even as a means of supplying a small community or industry from a single isolated bore. For such a machine, low capital cost would be more important than high efficiency. The adaptation of Hero's principle, discovered nearly 2000 years ago, together with the exploitation of the well-known self-regulating flow characteristics of nozzles when passing boiling water, could fulfill this need, even making possible a turbine that could accept water-steam mixtures from a "wet" field without the provision of an external separator. The total absence of blading and the simplicity of construction would be conducive to rapid manufacture and low capital costs, while a standard design could be adapted to various bore characteristics and required outputs simply by changing fixed nozzles.

24251 Geothermal plants: gas removal from jet condensers. Dal Secco, A.G. (Franco Tosi Co., Legnano, Italy). pp 1943-1948 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

The selection of extractors for incondensable gas is discussed on the basis of several parameters: the mass flow of incondensable gases to be removed from the condenser, the condenser vacuum, and the cooling water flow and temperature. Diagrams of mass flow, capacities, and power absorbed are given as functions of the intake pressure and temperature as well as of the mixture characteristics. Designs for the latest compressors under construction for Larderello are also described.

24252 Applicability of the binary cycle. James, R. (Dept. of Scientific and Industrial Research, Taupo, N.Z.). pp 2007-2011 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Because of declining reservoir pressure under exploitation, a geothermal power project has to be designed for an operating wellhead pressure which falls as low as 70 to 80 psig during the economic life of the scheme. This rule applies equally to a binary cycle as to a conventional two-stage flash cycle based on a pressured hot-water reservoir. Such a comparison reveals that the thermal efficiency of the binary cycle is less than that of the conventional system, due to the low temperature of the flashing primary fluid entering the heat exchanger. This result would be reversed, however, with the development of a successful deep-well pump which would pressurize the primary fluid so that its temperature on entering the heat exchanger is as high as that of the deep reservoir.

24253 Working fluid selection and preliminary heat exchanger design for a Rankine cycle geothermal power plant. Kihara, D.H.; Fukunaga, P.S. (Univ. of Hawaii, Honolulu). pp 2013-2020 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

There have been proposals for geothermal power plants using a Rankine cycle with a low boiling point fluid as the working fluid. In this study a list of possible working fluids with wide ranges of property values is examined; and two, isobutane and R-114, are selected as being representative of the type of working fluid that might be selected by plant engineers. Heat exchangers will be at the interface between the geothermal fluid and the working flud and will constitute an essential component of this particular means of energy conversion. A parametric study is conducted of a vertical, counter-flow, shell-and-tube heat exchanger designed for use in a 10-MW geothermal power plant which utilizes geothermal brine at moderate temperatures. The computational procedure for determining the required brine flow rate, tube lengths, number of tubes, and pressure drops is outlined. Detailed in graphical form are results showing how these parameters are affected by changes in working fluid, turbine inlet temperature, system pressure, and scale thickness. This study shows that the minimum brine flow rate for each working fluid occurred at a supercritical system pressure. However, the tube lengths for these turbine inlet conditions were at a maximum. The tube lengths for the subcritical system pressure were substantially less but resulted in larger pressure drops.

24254 Applications of low-temperature heat carriers in geothermal energetics for use as a secondary energy source in industry.

Kutateladze, S.S.; Moskvicheva, V.N.; Petin, Yu.M. (Inst. of Thermophysics, Novosibirsk, USSR). pp 2031-2035 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Man's use of high-grade energy sources is at present extremely inefficient, with 75 to 80 percent of the energy of typical fuels commonly being lost instead of being converted into work. The world supply of high-grade fuels is rapidly being diminished; the waste heat increases the thermal pollution of the environment. However, by means of low-potential power-extraction devices, much of the waste energy might be recovered and put to use. This is borne out by experience with low-temperature geothermal sources, which resemble industrial and other waste-heat exhausts in their temperature range (100 to 200°C). Working fluids with lower boiling points than water's can be used to drive turbines at better efficiencies than those attainable through a low-temperature steam cycle or other direct water-based processes. Described is the Freon-driven turbine system installed at the Stredne-Paratynsk hot springs in Siberia, which uses geothermal water at only 80°C as its heat source. While the design of systems for use with Freon or other organic fluids requires special considerations, the system tested performs as theory predicts and supports confidence in the concept. Thus, low-boiling-point machines offer promise for the recovery of energy now lost as waste heat in mankind's industrial and power-generating processes.

24255 San Diego Gas and Electric Company's pioneering geothermal test work in the Imperial Valley of Southern California, USA. Lombard, G.L.; Nugent, J.M. (San Diego Gas and Electric Co., CA). pp 2037-2043 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Geothermal energy from steam and hot brines in the Imperial Valley of southern California, USA, is as yet untapped, but has the potential for a significant contribution to the energy supply of the region. San Diego Gas and Electric Company is engaged in a field testing and development program for the extraction of this energy. The main problems lie in the high salinity of the brines (average, 225,000 ppM), the entrainment of corrosive solids in the steam, and the significant amount (3 percent by weight) of noncondensable gases in the fluids. A binary-cycle generating system is planned, which will use isobutane as a working fluid and two-stage flashing to extract the geothermal heat. In 1973 and 1974, laboratory and field tests showed some difficulties with scaling in the equipment and in the reinjection system, but these problems have proved to be tractable. During 1975, San Diego Gas and Electric Company has been building a 10-MW Geothermal Test Facility near Niland, California, at the southern end of the Salton Sea, for the next stage in the developmental work for the extraction of commercial geothermal power from this field.

GEOTHERMAL ENGINEERING

24256 (TREE—1008) **Geothermal R and D Project report for period April 1, 1976 to June 30, 1976.** Kunze, J.F. (ed.). (EG and G Idaho, Inc., Idaho Falls (USA)). Oct 1976. Contract EY-76-C-07-1570. 59p. Dep. NTIS $4.50.

Progress during April to July 1976 in research on geothermal energy is reported. The experiments are performed in the Raft River Valley, Idaho, a hydrothermal resource site with water temperatures below 150°C. During this period, a third well, RRGE-3 was drilled and well production was tested, testing of a direct contact heat exchanger continued, design and cost estimating continued on a 40 MW (th) organic-binary heat exchange facility, agricultural studies of irrigation with geothermal water progressed, and down-hole data was obtained from RRGE-3. (LCL)

24257 Summary of Section VII: production technology, reservoir engineering, and field management. Nathenson, M. (Geological Survey, Menlo Park, CA). pp xcvii-ci of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Vol. 1. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P1.

The reservoir engineering and production technology of geothermal resources are grouped under six headings: (1) "Hydrothermal Reservoirs" discusses papers giving reservoir and geophysical data for several systems. (2) "Well Operations and Analysis" contains topics such as analysis of pressures in shut-in and flowing steam wells, short-time pressure response of shut-in wells, properties of two-phase flow in wells in hot-water systems, stimulation of hot-water wells by injection under pressure, a new platinum-resistance thermometer for logging, and the use of radon as a diagnostic in reservoir studies. (3) "Reservoir Modeling" discusses work that analyzes nonisothermal flow of single- and two-phase fluids in reservoirs, to understand various aspects of undisturbed and producing geothermal systems, and includes some laboratory data related to reservoir modeling. (4) "Fluid Transmission" deals with problems of orifice plates, steam-water flow in horizontal pipes, and the scrubbing of chlorides from water that is entrained in a steam flow. (5) "Corrosion and Deposition" describes recent investigations into materials problems. (6) "Forced Recovery" describes work on these schemes.

DRILLING TECHNOLOGY AND WELL HARDWARE

REFER ALSO TO CITATION(S) 24225

24258 Summary of Section VI: drilling technology. Nathenson, M. (Geological Survey, Menlo Park, CA). pp xcv-xcvi of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Vol. 1. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P1.

Various aspects of drilling geothermal wells are dealt with. Current drilling practices and improvements in current drilling practice are summarized. Advanced technology research is described. The magnitude of the drilling program needed to reach 20,000-MW capacity in a 10-year program in the U. S. is estimated to be about 8000 wells using 100 drill rigs.

24259 Redevelopment of the Reykir hydrothermal system in Southwestern Iceland. Thorsteinsson, T. (National Energy Authority, Reykjavik). pp 2173-2180 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

The Reykir hydrothermal system has been exploited since 1944 for space heating in Reykjavik, 15 to 20 km distant. Prior to 1970, production amounted to 300 l/sec, 86°C, by free flow from 69 narrow-gage wells with a maximum depth of 628 m. In early 1970 a redevelopment of the hydrothermal system was begun by the rotary drilling of deep large-gage wells intended for production by submergible turbine pumps. By March 1975, 29 rotary-drilled wells, 800 to 2043 m deep and 22 to 31 cm in diameter, had been completed. Production from these wells is expected to exceed 1200 l/sec, while production from the 20 wells already equipped with turbine pumps in January 1975 amounted to 851 l/sec with an aggregate temperature of 83.5°C. Future production potential of the system is estimated to exceed 1500 l/sec with a water-level decline of 60 to 70 m from the 1970 steady-state water level. The essentially horizontal thermal aquifers at Reykir are irregularly distributed, both laterally and vertically, through volcanics of Quaternary age. Values of transmissivity and coefficient of storage, as determined from pumping tests, range as high as 2.6×10^{-2} m²/sec and 2×10^{-4}, respectively. The artesian nature of the aquifers is suggested by the value of the storage coefficient and by the response of the aquifers' pressure heads to atmospheric pressure changes, earth tides, and distant earthquakes.

FLUID TRANSMISSION

24260 Experimental study on transient phenomena in steam-water mixtures flowing through a large pipe line for geothermal power stations. Soda, M. (Mitsubishi Heavy Industries, Ltd., Nagasaki); Takahaski, Y.; Aikawa, K.; Kubota, K.; Ejima, Y. pp 1789-1795 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

An experimental result on transmitting steam-water mixtures through pipes for hot-water-type geothermal power plants is presented. The present experiment was carried out at Hatchobaru using a larger test line, and putting stress on investigating the transient flow of mixtures caused by turbine trip. The test line used was a 300-

mm-dia pipe about 200 m in length, arranged sloping downward about 7°, and provided with a shut-off valve at its exit. Even at a moment when the flow of mixtures was quickly shut off at the end of the pipe, the pipeline was sufficiently stable without any sounds or vibrations. The stability could be confirmed by visual observations of flow pattern and by oscillograph recordings of line pressure. The sudden rise of pressure at a point just before the shut-off valve was very small in comparison with the settling rise of line pressure, which coincided with that estimated as if only the steam phase had been injected into the line from the bore. In addition, the pressure drop of mixtures in steady states almost agreed with the Lockhart and Martinelli correlation when the superficial homogeneous velocity of mixtures was higher than 20 m/sec, and the typical flow pattern of mixtures was a semi-annular mist flow. Furthermore, the pipe's inner surfaces were inspected after the 74-day long-run test; only a little scale deposit was observed and no sign of erosion and corrosion was found.

CORROSION, SCALING, AND MATERIALS DEVELOPMENT

24261 Corrosion of turbine materials in geothermal steam environment in Cerro Prieto, Mexico. Tolivia M., E. (Federal Electricity Commission, Mexico City); Hoashi, J.; Miyazaki, M. pp 1815-1820 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

In starting to construct electric power generation plants utilizing geothermal steam, corrosion resistance of the turbine materials in the corrosive environments was investigated. From the test results, it was found that aeration of the steam and increase of flow velocity of the condensate not only enhance the corrosion rates of the materials to a remarkable extent but also greatly change the corrosion behavior. In selecting materials, therefore, it is important to investigate thoroughly the corrosion characteristics of each material by analyzing the behavior and confirming deterioration of mechanical properties, in addition to evaluating corrosion rates. In this regard, it is recommended to use the test data effectively in the following manner. Carbon steel is usefully resistant for shell and piping in separated steam because its corrosion rate is low and follows a parabolic rate law. In condensate, however, design requires such considerations as corrosion allowance or coating with epoxy resin due to the high corrosion rate. As for 12-chromium steels for blades, reductions in the fatigue endurance limit due to corrosion are more serious than the general corrosion rates. In view of the fact, design consideration in respect to the determination of allowable stress should be required. Low-alloy steels for the rotor are nearly equal to carbon steel in their corrosion rates. Cr-Mo-V steel is more advantageous than Ni-Cr-Mo-V steel, which deteriorates markedly in its mechanical properties due to intergranular corrosion. Aluminum and deoxidized copper are unserviceable for heat exchanger tubes because of their poor corrosion resistance in condensate. Titanium seems to be most suitable for them from our experience.

24262 Scale deposition and control research for geothermal utilization. Wahl, E.; Yen, I. (Occidental Research Corp., La Verne, CA). pp 1855-1864 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Scale deposition from geothermal brines depends on the brine composition, temperature, pressure, and process conditions. Relationships between brine chemistry, process conditions, and scale deposition are exemplified by experimental results. Silica and silicate deposits depended on the content of minor cationic constituents. A synthesized brine deposited silica according to an exponential model. Brine from the East Mesa Well 6-1 deposited calcite at a constant rate which depended on the flashing of the brine and separation of the vapors, but was independent of heat flux. The chemical and physical natures of the deposits show that the deposition is quite sensitive to process conditions. Of several approaches to research on scale deposition, the recommended one is an experimental study with real brines in equipment arranged to simulate actual processes to determine mechanism, kinetics, and equilibria involved. The purpose is to provide data and semi-empirical models to relate brine chemistry, process conditions, and scale deposition for designing systems to avoid or control deposition.

24263 Results and improvements of water treatment in the cooling water system of Otake Geothermal Power Plant. Yasutake, H. (Kyushu Electric Power Co., Inc., Yutsubo, Japan); Hirashima, M. pp 1871-1877 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

The Otake geothermal power plant has been operating satisfactorily since August 1967. In the initial stage of operation, however, some problems (such as corrosion and scaling from impurities in the steam and formation of sludge by make-up water) had occurred in the cooling water line. Thus far, the causes of the problems have been investigated, solutions have been considered, and improvements have been made in each case. Details of the following items are presented: the state of corrosion in the cooling water line and investigation of its causes; injection of caustic soda into the cooling water line for prevention of corrosion; examination of corrosion-resistant materials in the steam and cooling water systems; prevention of sludge formation due to make-up water in the cooling water line; and results of periodic inspections at the main parts of the steam and cooling water systems.

24264 Material and corrosion testing at the Geysers Geothermal Power Plant. Dodd, F.J.; Johnson, A.E.; Ham, W.C. (Pacific Gas and Electric Co., San Ramon, CA). pp 1959-1963 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Pacific Gas and Electric Company's 10 operating units use geothermal steam to directly propel steam turbines and recirculate condensed steam as cooling water. Corrosion is a major consideration in the selection of materials exposed to the atmosphere, soil, geothermal steam, or condensate at The Geysers. Initial tests lead to the selection of conventional turbine, stator, rotor, and blading materials; aluminum and austenitic stainless steels for the condensate system; and aluminum for line hardware. Atmospheric corrosion testing has been performed and has shown that austenitic stainless steels and aluminum alloys have satisfactory corrosion rates. Galvanized, cadmium plated, copper alloyed, and carbon steel exhibited excessive corrosion. Steam turbine blades have suffered repeated blading fatigue failures. Mechanical properties of the blading materials made of 12 percent-chromium stainless steel are sensitive to slight variations in heat treatment and are notch sensitive in Geysers steam. Fatigue tests of blading material have been initiated to determine a satisfactory heat treatment or a more suitable material for turbine blading. Chemical treatment of recirculating condensate to remove hydrogen sulfide gas has been initiated. Tests were made in the condensate system in order to determine the effects on material corrosion rates. Tests to date reveal increased corrosion rates with chemical addition.

24265 Corrosion rate monitoring at the Geyses Geothermal Power Plant. Hanck, J.A.; Nekoksa, G. (Pacific Gas and Electric Co., San Ramon, CA). pp 1979-1984 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

At the Pacific Gas and Electric Company's geothermal plant located at The Geysers in northern California, steam removed from the earth is piped directly to individual plant units where it is used to run low pressure turbines. This steam is later condensed in barometric condensers, after which it is used as cooling water. Inspection of several of the cooling systems showed severe localized corrosion in aluminum piping and some pitting on 316 stainless steel pumps and condensers. Corrosion monitoring equipment is being used at several of the power plant units to predict the life expectancy of the cooling system components. Each monitoring system includes corrosion test vessels, electrochemical probes, related measuring and recording equipment, electro-resistance probes, and pipe- and plate-type corrosion coupons. The paper discusses various corrosion mechanisms that have been encountered in geothermal environments at The Geysers and describes the results of electrochemical and electrical resistance techniques. Data reported include corrosion rates, pitting and corrosion susceptibility as determined from polarization curves, electrochemical probe potentials, water flow, temperature, and condensate chemistry. Also discussed are the corrosion monitoring programs for different hydrogen sulfide abatement techniques and selection of corrosion inhibitors.

GEOTHERMAL RESERVOIR AND WELL PERFORMANCE

REFER ALSO TO CITATION(S) 24224, 24259

24266 Thermometer for geothermal thermometry in geothermal wells. Ushijima, K. (Kyushu Univ., Fukuoka); Nishikawa, K.; Ito, T.; Matsumoto, K.; Noguchi, T. pp 1829-1834 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Geothermal thermometry in geothermal wells is carried out to detect the channels through which geothermal fluids enter a borehole and to determine the temperature distribution in geothermal fluids. The location of the cement tops behind the casings of a well is also determined by temperature measurements in wells. In order to treat the temperature variations due to drilling operations or other nonstationary processes analytically, it is necessary to obtain reliable temperature logs. An accurate and inexpensive thermometer using a platinum wire resistor as a sensing probe has been developed to meet the increasing requirements for reliable temperature logs, and was named a geothermometer. The geothermometer was designed to meet such specificatiens as having a measuring range up to 300°C and being waterproof up to 150 bar. The laboratory tests of the thermometer confirmed that it worked satisfactorily up to a temperature of 213°C and an external pressure of water less than 90 bar. In the field tests in the Denken borehole at the Otake geothermal area, Ohita, Japan, the performance of the thermometer was checked with a maximum depth of 340 m and a maximum temperature of 176°C. The structure of the thermometer, temperature calibration, hydraulic tests, method of determination of time constant, and field tests are explained in detail.

RESERVOIR STIMULATION AND EXTRACTION TECHNOLOGY

24267 Use of injection packer for hydrothermal drillhole stimulation in Iceland. Tomasson, J.; Thorsteinsson, T. (National Energy Authority, Reykjavik, Iceland). pp 1821-1827 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Injection packers have been used in Iceland since 1967 to increase the productivity of 30 hydrothermal drill holes, drilled in and near Reykjavik for space-heating purposes. The rotary-drilled holes, which range in depth from 800 to 2000 m and from 22 to 31 cm in diameter, penetrate fresh and hydrothermally altered basalts and hyaloclastites of Quaternary age. During stimulation, the inflatable packer is set between two or more producing horizons in the hole, and water in turn is injected beneath and above the packer. The rate of pumping is from 30 to 100 l/sec and varies according to the resistance of the producing horizons to flow. Well-face pressures range from a few kg/cm² to 60 to 70 kg/cm² at 30 l/sec in highly resistive horizons. Tests have revealed three- to fourfold increases in productivity by this process. At Reykir the production of one treated well has reached 81 l/sec with a drawdown of 9 m, but usually it exceeds 40 l/sec with drawdowns of less than 50 m. This increase in productivity is predominantly attributable to the reopening of producing horizons clogged by drill cuttings and by circulation materials lost during drilling, but also to the removal of zeolite and calcite vein deposits and to the increase in the permeability of the hyaloclastic rocks in the immediate vicinity of the holes. The injection packer has proved to be a valuable tool for determining the hydrologic characteristics of the hydrothermal systems. The fluctuation of water levels in observation drill holes of various depths reflects transmissivities and impervious barriers of the various producing horizons of the hydrothermal systems.

DIRECT ENERGY UTILIZATION

REFER ALSO TO CITATION(S) 24237, 24243, 24256

24268 Summary of Section IX: space and process heating. Armstead, H.C.H. (Rock House, South Devon, Eng.). pp cxi-cxv of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Vol. 1. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P1.

Geothermal power generation is essentially an inefficient process owing to inescapable thermodynamic restraints, and the lower the temperature of the heat source, the lower will be the efficiency of power generation. On the other hand, the direct use of geothermal heat for space heating and domestic hot-water supply, industrial processes, or for husbandry can be highly efficient. Another important fact is that the sources of high-enthalpy natural heat at present accessible to man and which are suitable for power generation are believed to be far less abundant than those of lower-enthalpy fluids which can be used for other purposes. Furthermore, practical applications can be found to cover a very wide spectrum of temperature extending down to about 30°C for balneology, biodegradation, and fermentation, and even down to about 20°C for fish hatcheries. Finally, a very large proportion of the world's energy consumption is in the form of heat, rather than electricity. Space heating and domestic hot-water supply form the principal subject of the papers submitted but other nonpower uses have not been altogether neglected.

24269 Summary of Section X: other single and multipurpose developments. Barr, R.C. (Earth Power Corp., Tulsa, OK). pp cxvii-cxix of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Vol. 1. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P1.

The papers in this section are summarized with the observation that geothermal resources may be utilized primarily for electrical purposes and, secondarily, for nonelectrical purposes. Exceptions to this ordering will occur in areas where the geothermal resource is plentiful or where the exploration risks, and hence anticipated costs, are minimal. The elecrical-nonelectrical priorities have been assigned in the context of a geothermal resource producing the energy equivalent of tens or hundreds of thousands of barrels of oil per day. The geologic criteria and economic parameters for the generation of electricity are described. Two papers on Iceland describe multipurpose utilization in areas where the resource is both abundant and exploration risks (costs) are minimal.

24270 Exploitation of saline high-temperature water for space heating. Arnorsson, S. (National Energy Authority, Reykjavik); Ragnars, K.; Benediktsson, S.; Gislason, G.; Thorhallsson, S.; Gronvold, K.; Lindal, B. pp 2077-2082 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Pilot plant tests carried out in the Svartsengi high-temperature area of southwestern Iceland show that direct heating of fresh water with steam derived from the 235°C saline geothermal water yields hot water with good qualities for space heating and domestic use. The fresh water is heated to 110 to 120°C and flashed at 1 atm pressure to degas it. During degassing, O_2, that was originally in the fresh water, is removed; and CO_2 and H_2S, which are derived from the steam, are substantially lowered. At the same time the pH is raised. Other heat exchange methods were tested, but the direct heating method is no doubt most economical and technically superior. Flashing the heated water in steps would still improve the effective energy use. It is the chemical composition of the steam and fresh water respectively that determines the quality of the heated water, and the extent of the degassing. It seems likely that the direct heating method could be applied generally, when otherwise unsuitable geothermal fluids are intended for space heating. It is planned to exploit the saline high-temperature water in Svartsengi for house heating for all the larger communities in the western part of the Reykjanes Peninsula and the international airport at Keflavik. The estimated energy consumption is about 80 MW (thermal). Exploratory drilling has been completed and four wells are available for utilization with a total capacity of 70 to 80 MW. The exploitation stage will be reached in 1976-1977.

24271 Some aspects of the utilization of geothermal fluids from the geothermal fields in the Northwest Himalayas. Behl, S.C.; Jegadeesan, K.; Reddy, D.S. (Geological Survey of India, Lucknow). pp 2083-2090 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Preliminary studies were conducted in the northwest Himalayas on utilization of geothermal fluids for space heating, greenhouse cultivation, and refrigeration. In the Puga geothermal field of Ladakh, extreme climatic conditions prevail. A shed was erected and steam from a nearby geothermal well was used to heat it with an aluminum-finned copper-tube radiator-convector. By this arrangement, a difference of 25°C was recorded with reference to atmospheric temperature, and the economics and utility of space heating

were thus demonstrated. Chumathang village inhabitants are constrained by the climate to do farming only during summer. To study the feasibility of cultivation in winter, a greenhouse was installed and hot water from a nearby geothermal well was led into it to heat the soil and environment separately. The germination of seeds and the growth of plants in the greenhouse have been satisfactory. About 500,000 l/hr of hot water around 90°C flow out from the natural thermal outlets in the Manikaran geothermal field of Himachal Pradesh. A 100-ton cold storage plant, utilizing an ammonia-water-absorption system for the preservation of locally produced apples and potatoes, can easily be run by the available supply of hot water from thermal outlets and cold water from the nearby Parbati river. The experiments conducted for space heating and greenhouse cultivation were quite successful and are to be continued for standardization of techniques and improvement of methods. At Manikaran the design of a 10-ton prototype cold storage plant is being taken up.

24272 Geothermal resources for heat treatments. Chiostri, E. (Corso Vittorio Emanuele, Naples). pp 2094-2097 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

The potential of geothermal resources is not only to provide energy and heat sources for technical development: in natural hot waters mankind has often discovered, through the centuries, curative properties due not only to their temperature, but also to the physico-chemical properties of the salts and the gases dissolved in them. Such waters can be used for several kinds of treatment depending upon their composition: as a potable remedy for gastrointestinal diseases; in the form of baths (often in connection with treatments with natural muds in arthritic and rheumatic afflictions; in the form of inhalation for diseases of the respiratory system. The use of these natural treatments is especially important in the areas of preventive and mass medicine. Consider the imposing number of working days lost in the whole world because of a plague having a social scope like rheumatism which can be stopped or made less severe precisely by these natural treatments. It is proposed to the study committees on geothermal resources that the curative factory be given its place in the classification and the exploitation of these resources.

24273 Conditions for the competitive use of geothermal energy in home heating. Coulbois, P.; Herault, J.P. (Bureau de Recherches Geologiques et Minieres, Orleans Cedex, France). pp 2104-2108 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

The use of low-temperature (55 to 80°C) geothermal energy requires very large, nondivisible investment (a minimum of about 5 to 6 million French francs for each operation in 1974) which is partly independent of the quantity of heating to be supplied. It is possible, however, to vary the caloric power of the installation by hot-water pumping which entails operating costs. A geothermal installation can only really be competitive for the maximum power ranges and for variable annual quantities of heat according to the resource (location, temperature) and the characteristics of the secondary heating appliance. The cost of geothermal heating may be calculated according to these various factors and then compared with the cost of other heating methods.

24274 Utilization of geothermal water for domestic heating and hot water supply. Dvorov, I.M.; Ledentsova, N.A. (Scientific Council on Geothermal Research, Moscow). pp 2109-2116 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

A number of principal schemes for the utilization of geothermal water have been developed. There are schemes for direct and parallel utilization of geothermal water, a scheme with peak heating and compression thermo-transformer, and a scheme with combined systems of water and air heating. The choice of the best schemes of utilization of geothermal energy is carried out according to different factors—the depth of bed, strength of rocks, yield of wells, temperature, rate of mineralization, chemical composition, climate, cost of fuel, and distance to the sites of use. The possibilities of application of different types of systems of heating were investigated; they are panel (ceiling-floor type), convector, air heating systems, and new types of heating installations. Installations utilizing geothermal water already exist in some regions.

24275 Geothermal space heating and cooling. Einarsson, S.S. (United Nations, Managua). pp 2117-2126 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Space heating is one of the most successful present applications of geothermal energy. It can substitute for more versatile and valuable sources of energy like electricity or fuel oils and eliminate the pollution associated with the latter. However, limitations are set by the relatively low temperature level and transportability of geothermal heat as compared to other energy sources. The cost structure of geothermal heat delivered to the consumer is analyzed with a view to the principal parameters, such as the production cost at the source, long-distance transportation costs, and distribution costs within the market area, as well as temperature level, annual load factor, and the size of the market. The results are presented graphically in order to determine the maximum economic distance of transportation in relation to the cost of alternative energy sources. The findings apply to other nonpower uses of geothermal energy such as industrial heating, refrigeration, and others. Examples of existing installations are described both in the field of house heating and other applications; and some pertinent climatic, technical, and economic problems are discussed. New potential uses such as district air conditioning of tropical cities are mentioned, and institutional problems are touched.

24276 Utilization of intermediate-temperature geothermal water in Klamath Falls, Oregon. Lund, J.W.; Culver, G.G.; Svanevik, L.S. (Oregon Inst. of Tech., Klamath Falls). pp 2147-2154 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Klamath Falls, Oregon, is located in a Known Geothermal Resource Area which has been used by residents, principally to obtain hot water for space heating, at least since the turn of the century. Approximately 400 shallow-depth wells ranging from 27 to 580 m (90 to 1900 ft) in depth are used to heat approximately 500 structures. This utilization includes the heating of residences, schools, businesses (including a creamery for milk pasteurization), the heating of swimming pools, and the melting of snow from pavements. Well water, which ranges from 38°C (100°F) to 110°C (230°F) has been used directly in heating and drinking-water systems; however, present practice is to use downhole hairpin-type heat exchangers with city water as the circulating fluid. Well water chemistry indicates approximately 800 mg/l (ppM) dissolved solids, with sodium and sulfate having the highest concentrations. Calcium and potassium concentrations are very low. Some scaling and corrosion does occur on the downhole heat exchangers (black iron pipe) which is related to the Langelier Saturation Index. Cost analyses for capital and annual operation costs are presented and compared with those for alternative forms of energy (electricity, natural gas, and fuel oil). For a single residence, at today's costs, heating by use of geothermal water appears to be somewhat competitive; however, when several structures use the same well, the savings are substantial. District heating, similar to that in operation in Iceland, is proposed. The average annual energy utilization is only 5.6 MW with peak use at 56 MW. It is felt that only a small portion of the area's potential is being utilized, and a potential of steam exists at greath depth.

24277 Potential for nonelectrical applications of geothermal energy and their place in the national economy. Reistad, G.M. (Oregon State Univ., Corvallis). pp 2155-2164 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Electricity generation from geothermal resources is the current major focus of research and development in the U.S. Although electricity generation from these resources has the advantage of location independence, there are a number of other factors which indicate that nonelectrical applications have more long-range potential. Some of these factors are: (1) the geothermal resource which exists at low to medium temperature is estimated to be much larger than that at higher temperatures; (2) a very large proportion of the basic energy needs of any industralized nation is for heating at low to medium temperatures; and (3) low- to medium-temperature heating needs are difficult to meet efficiently from either electricity or fossil fuels, as is indicated by the poor thermodynamic performance

of most of the present systems supplying such needs. This paper estimates both the amount of direct heating that could be used to meet the basic energy requirements of an industralized nation and the temperatures that are required. The energy requirements of the U.S. are evaluated to determine the potential substitutions of geothermal energy that could result in sizable direct applications. Evaluation is limited to uses that have temperature requirements typical of geothermal resources. Here, 250°C is considered the maximum temperature for direct applications. The aspect of geographically matching potential applications with known or potential resources is not considered. It is estimated that more than 40 percent of the total energy requirements of the U.S. could be satisfied from geothermal resources with heating at a maximum temperature of 200°C if the resource is available at each application site. The similar percentages at 150 and 100°C are 30 to 20 percent respectively.

24278 Geothermal heating of government buildings in Rotorua. Shannon, R.J. (Ministry of Works and Development, Hamilton, N.Z.). pp 2165-2172 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

In New Zealand, Rotorua is a tourist center with much thermal activity. Most commercial buildings in the city have geothermal heating. The government center has a small district heating scheme where improved techniques have been used in controlling geothermal resources, to comply with government legislation. A variety of heat exchangers have been used with the aim of reducing capital and maintenance costs. At Queen Elizabeth Hospital conventional coal-fired boilers have been replaced with fully automated geothermal heat exchangers, generating low-pressure clean steam for heating and other hospital services. A review of government buildings using geothermal heating has shown a substantial saving in traditional fuels, but the economics of using geothermal water for heating buildings depends largely on the source of supply being near the area of demand.

24279 Optimal recovery of geothermal heat for process steam. Valfells, A. (Univ. of Iceland, Reykjavik). pp 2181-2184 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

The price of steam is a significant economic factor in many energy-consuming processes. Presently, steam generated by the burning of fossil fuels costs from $1.00 to over $5.00 per ton, depending on location and availability of fuels. Geothermal steam is the cheapest steam presently available (less than $0.50/ton). For those energy-consuming processes where the temperatures available with geothermal steam do not offer a limitation, and where the relatively remote siting of most geothermal fields does not offset the advantage of cheap thermal energy, geothermal steam certainly seems to be the most advantageous energy source. The optimum design of a system for the recovery of geothermal heat for use in a chemical process depends on the process and the characteristics of the field. Typically, however, the cost of geothermal steam at any field will vary in a semiexponential fashion with the pressure at which it is flashed from the water. This makes it economical to put the heat into the process where it is to be utilized, at several different temperatures. Sequential flashing may be used for this purpose. For example, the water from a borehole may be flashed to produce 35 t/hr of steam at 170°C; the condensate after utilization combined with the fraction that was not flashed; and the flashing can be repeated to produce 21 t/hr of steam at 150°C. The process may again be repeated to produce 18 t/hr at 130°C. The remaining liquid and condensate still contain much sensible heat, which may be used for preheating. Constraints are imposed on the system by the amount of dissolved silica and other solids in the geothermal water. The silica precipitates out as opal, and this sets lower limits to the temperature drop which can be realized for the geothermal water.

24280 Production of fresh water by desalting geothermal brines: a pilot desalting program at the East Mesa Geothermal Field, Imperial Valley, California. Fernelius, W.A. (Bureau of Reclamation, Boulder City, NV). pp 2201-2208 of In Proceedings of the second United Nations symposium on the develoment and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

The U.S. Bureau of Reclamation is currently exploring the geothermal resources on the East Mesa of Imperial Valley, California. The purpose of the Bureau's research and development program is to determine the feasibility of desalting mineralized geothermal fluids. The additional fresh water developed in the Imperial Valley can be used to augment the flows of the Colorado River system. Two test desalting units, a multistage flash (MSF) and a vertical tube evaporator (VTE), have been installed and are being operated to evaluate the distillation processes for desalting geothermal fluids. Each unit was designed to produce 75 to 190 m^3/day of distilled water. Around-the-clock operations have been successful at both units, with minor scaling and corrosion problems. Heat transfer tubes of various materials have been tested in the VTE unit. Smooth copper-nickel and titanium tubes are installed, and a full series of tests is being run. Test parameters consist of upflow and downflow modes of operation, feed fluid temperatures of 104 to 160°C, tube diameters of 3/4 to 2 in. with lengths up to 6 m, feed flow rates of 25 to 230 kg/min liquid, and total flashdown characteristics from feed to blowdown. To date, five deep test wells more than 1800 m in depth have been completed. Bottom-hole temperatures of the deep holes range from 154 to 204°C. Mesa 6-1 and Mesa 6-2 are production wells. Mesa 5-1 is being developed as an injection well on the basis of both surface and subsurface geophysical data. The other two wells, Mesa 31-1 and Mesa 8-1, will be tested as production wells.

24281 Total energy utilization potential of Alaskan thermal springs. Forbes, R.R.; Leonard, L.; Dinkel, D.H. (Univ. of Alaska, Fairbanks). pp 2209-2215 of In Proceedings of the second United Nations symposium on the develoment and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

There are 95 or more thermal springs in Alaska. Based on geologic and geochemical data, we do not know of any Alaskan thermal springs that are related to vapor-dominated or large hot-water reservoirs which have the potential for generating large amounts of electricity. Heat is a precious commodity in the arctic and subarctic, and thermal springs are promising energy sources for rural Alaskan communities. Although small amounts of electricity could be generated from springs with higher flow rates and temperatures by Rankine cycle organic-working-fluid systems, nonelectric applications show greater promise. An optimum total energy system designed for a small, isolated Alaskan village would generate a small amount of electricity (40 to 60 kW) with the subsequent extraction of energy for space heating, controlled-environment agriculture, fish farming and hatchery operations, and sewage processing and disposal. Phased experiments and pilot studies are planned for Manley, Clear Creek, and Pilgrim Springs from 1975 to 1977 to test the engineering feasibility of this concept.

24282 Geothermal hydroponics. Gutman, P.W. (Hobo Wells Hydroponics, Inc., Wendel, CA). pp 2217-2221 of In Proceedings of the second United Nations symposium on the develoment and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

The uses of geothermal energy run the gamut from electrical power generation to bathing. It is probably one of the most versatile and relatively nonpolluting forms of energy known to man. This paper deals with a specific use of geothermal water—the production of vegetables and related problems in greenhouses using a soilless growing technique called hydroponics.

24283 Multipurpose uses of geothermal energy: electric power generation and horticultural production. Ludviksson, V. (Industrial Development Committee, Reykjavik). pp 2229-2236 of In Proceedings of the second United Nations symposium on the develoment and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

The heating of greenhouses already presents an important use of geothermal energy in Iceland. The heat is usually supplied in the form of hot water at about 100°C. Greenhouse industries at northern latitudes have commonly used the equivalent of 100 kg/m^2 in a year to provide the necessary heat to maintain production. At far northern latitudes, light becomes a limiting factor in winter production of horticultural products. The steam from high-temperature thermal fields can be used to produce electricity while the residual heat from flashed geothermal water and possibly the condensation can be used for artificial lighting and temperature control for the cultivation of plants. An economic evaluation based on 33.5 hectares of glass houses and a 14-MW steam power plant shows that the cost of heat to the greenhouse complex would be about 2 percent of the total operating cost, while the same energy from an oil or other hydrocar-

bon source would result in about 35 to 40 percent of the operating cost at correspondingly higher total operating cost. The effectiveness of artificial lighting in maintaining or promoting plant production is a major unknown factor, which greatly depends on the type of light source, its arrangement, and the type of plant species to be produced. Research is being initiated on this subject in Iceland.

24284 Geothermal utilization in the Atagawa Tropical Garden and Alligator Farm: an example of successful geothermal utilization. Minohara, Y. (Central Research Inst. of Electric Power Industry, Chiba, Japan); Sekioka, M. pp 2237-2239 of In Proceedings of the second United Nations symposium on the develoment and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

This paper outlines the use of geothermal energy in cultivating plants and breeding animals in the Atagawa Tropical Garden and Alligator Farm at Atagawa, one of the famous hot springs near Tokyo. At present, 450 crocodilians of 27 species are bred, and artificial incubation of these species has succeeded by using hot water and steam from 4 hot-spring wells. Crocodiles are breeding in the various ponds with water at temperatures of 20 to 28°C. Water and body temperature are measured by infrared thermometer. By using hot-spring heat in the hothouse, more than 5400 species of tropical plants are grown, especially 63 species of tropical water lilies growing in a hothouse with regulated air and water temperature.

24285 Application of linear programming to multipurpose utilization of geothermal resources. Yuhara, K. (Kyushu Univ., Fukuoka); Sekioka, M. pp 2249-2253 of In Proceedings of the second United Nations symposium on the develoment and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Geothermal resources can be used for many purposes such as power generation, space heating, snow melting on roads, greenhouses, fish breeding, baths, and others. However, almost all types of utilization except power generation have difficulty in prospering as independent and profitable businesses because of their high costs and low benefits. Thus the use of individual geothermal water bodies at their second or third stage of utilization has to be considered. In order to get the maximum total benefit, it is important to consider the distribution of geothermal resources and the utilization systems. Linear programming can be applied to obtaining the optimum system for utilization of geothermal resources. As an example, linear programming applied to the Sounkyo Geothermal Utilization Plan is shown. In practical calculation, it is important to decide the restrictions of the linear programming, which have been obtained from the actual utilization of the geothermal resources of Japan.

24286 Aquaculture at Oregon Inst. of Technology. Johnson, B. (Oregon Inst. of Technology, Klamath Falls). *Q. Bull., Geo-Heat Util. Cent.;* 2: No. 1, 1-2(Jul 1976).

The geothermal hot water resource developed from on-campus wells is used for space heating and heating the college's potable hot water supply. The development of this resource has provided waste water for aquaculture. The available water for aquaculture is a volume of 200 to 250 gal/min with a mean temperature of 57°C. This water was tested on mosquitofish, guppies, and crayfish. A program is now underway to see if the giant freshwater prawn may be grown commercially in geothermal waste water. (MHR)

24287 Geo-heated swimming pool. Lienau, P. *Q. Bull., Geo-Heat Util. Cent.;* 2: No. 1, 2-3(Jul 1976).

Klamath Falls Municipal Swimming Pool has used geothermal energy for its heating needs the past 22 years. Its heating source is a 250 ft deep, 200°F artesian hot-water well. The 10-inch cased well has 200 ft downhole heat exchangers which supply heat to the pool, bathhouse, showers, and deck. Details of the circulation system and heat exchangers are given. (MHR)

24288 Home heating, 1930 style. Douglass, W.M. *Q. Bull., Geo-Heat Util. Cent.;* 2: No. 1, 4(Jul 1976).

Nonelectric uses of geothermal energy in Rotorua-Taupo area of North Island are alfalfa drying, soil pasteurization, and sulfur extraction and processing. Details of fluid temperatures and operating experiences are given.

24289 Nonelectrical use of residual steam from the Larderello Field, Italy. Allegrini, G. *Q. Bull., Geo-Heat Util. Cent.;* 2: No. 1, 6-8(Jul 1976).

The two main uses of residual steam are: for the heating of residential, public, and industrial buildings; and for the heating of greenhouses for agricultural production. Operating details of various systems are given. (MHR)

GEOTHERMAL DATA AND THEORY

PROPERTIES OF AQUEOUS SOLUTIONS

24290 Radon in geothermal reservoirs. Stoker, A.S.; Kruger, P. (Stanford Univ., CA). pp 1797-1803 of In Proceedings of the second United Nations symposium on the development and use of geothermal resources. Berkeley, CA; Univ. of California (1976).

From 2. United Nations symposium on the development and use of geothermal resources; San Francisco, California, USA (20 May 1975).

See CONF-750525—P3.

Radon release from geothermal reservoirs depends on the concentration and distribution of radium, the emanation properties of the radon, and the flow characteristics in the reservoir. At steady state, the radon concentration in produced geofluids is a function of the volumetric emanating power and effective porosity. Thus, radon may serve as a subsurface tracer in geothermal reservoir engineering for evaluating the effectiveness of stimulation techniques which change the value of these parameters. Because of its radioactivity, radon release is also of environmental concern. Several sampling and measurement techniques were evaluated to provide representative values of radon concentration for engineering and environmental studies. Results showed that radon concentration in geofluids from several geothermal reservoirs varied significantly with time. At production rates, the concentration of radon relative to both the condensate and the carbon dioxide component of the noncondensable gases varied not only between wells in a given field but also within a single well. Data at several flow rates indicated a possible dependence of effective emanating power on formation pressure. The effect of changing flow rate on the radon concentration may be predicted by theory. Tests during drawdown calibrations indicated an approach to steady-state concentration, perhaps independent of flow rate. The environmental impact of radon release to the atmosphere appears to be small and indistinguishable from the release of radon by natural emanation from the surrounding land mass.

WIND ENERGY

ECONOMICS

24291 Solar energy. Windpower: a new look at an old draft. *Mosaic;* 5: No. 2, 20-21(Spr 1974).

A brief discussion is presented on the potential of the wind for electric power generation. (WDM)

24292 Atomic power or windmills. Korsbech, U. (Danmarks Tekniske Hoejskole, Lyngby). *Ingenioeren;* 2: No. 31, 3-4(1976). (In Danish).

It is argued that if the Danish Ministry of Trade's plans for nuclear power in the nineties are changed to windpower, the price will be 5 times as high. A thorough estimation of the economy of a big Danish windpower program is given.

WIND ENERGY ENGINEERING

TURBINE DESIGN AND OPERATION

24293 (ERDA/NSF/00826—75/2) Wind energy conversion. Progress report, July 15, 1975—February 15, 1976. Miller, R.H.; Martinez-Sanchez, M.; Dugundji, J.; Larrabee, E.; Humes, T.; Chopra, I.; Smith, F. (Massachusetts Inst. of Tech., Cambridge (USA). Aeroelastic and Structure Research Lab.). 15 Feb 1976. Contract NSF-G-AER-75-00826. 181p. (ASRL-TR—184-2). Dep. NTIS $7.50.

Information is presented concerning control strategies for maximum power; loading in the presence of wind shear and gusts; aeroelastic stability margins; performance comparison between constant rpm and constant velocity ratio operation; synchronous alternators for wind energy conversion; experimental vibration behavior of windmill; experimental wind turbine model description; development of solution for finite number of blades; aerodynamic design and performance of windmills; linear aeroelastic analysis of blade; and nonlinear analysis of a feathering-flapping-lagging rigid rotor blade without aerodynamics.

24294 (ERDA-tr—230) Windmills in Tvind. Translated from *Ingenioeren;* No. 25-26, vp(Jun 1976). 13p. Dep. NTIS $4.00.

Design characteristics and operating parameters of wind turbines built by the Tvind, Denmark schools are presented.

ELECTRIC POWER ENGINEERING

POWER PLANTS AND POWER GENERATION

REFER ALSO TO CITATION(S) 23921, 24983

24295 Off-shore findings converted economically at sea into electricity. Utilization of low-caloric gases and small sources. Brandes, H.; Schiemichen, P.C. *Handelsblatt;* **29**: No. 42, 187(Oct 1976). (In German).

2 figs.

The use of an off-shore power plant for the current conversion of hydrocarbons of marginal fields of the south and middle North Sea is suggested. Depending on the site conditions, a pure gas turbine power plant or a combined steam-gas process can be used. Due to the distance from the coast (100 to 300 km), the power plants would need a high-voltage direct-current system for energy conversion.

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

REFER ALSO TO CITATION(S) 24734, 25297, 25298

24296 (BNWL-PFR—7-102) **Heat transfer and pressure drop characteristics of dry tower extended surfaces. Part II. Data analysis and correlation.** (PFR Engineering Systems, Inc., Marina Del Rey, Calif. (USA)). 15 Jun 1976. Contract E(45-1)-1830;SPAG-BSA-988. 69p. Dep. NTIS $4.50.

A summary is presented of studies of the heat transfer and pressure drop characteristics of extended surfaces. The summary is based on data that were compiled and analyzed with the objectives of determining the effects of geometrical configurations of an extended surface tube bank on its heat transfer and pressure drop characteristics. A generalized correlation of heat transfer and friction losses was developed on the basis of this analysis. These correlations can be used to predict the performance of an extended surface tube bank of specified geometry and flow conditions.

24297 Static calculation of hyperbolic cooling towers on account of earthquake loads. Cetmeli, E. *Bauingenieur;* **50**: No. 11, 417-423(1975). (In German).

8 figs.; 1 tab.; 23 refs.

A numerical calculation method is presented, whereby earthquake loads are assumed to be of a horizontal nature. Stress resultants and deformations are calculated for the membrane state. Approximative solutions for the determination of boundary disturbances on account of supports with high flexural strength are presented.

POWER CYCLES

REFER ALSO TO CITATION(S) 23905, 23915, 23919

COMPONENTS

REFER ALSO TO CITATION(S) 23892, 24525

24298 Utilization of the calorific value of gas-fired generators. Rado, L. (Ruhrgas A.G., Essen (Germany, F.R.). Gaswirtschaftliche Fachberatung); Wiedemann, K.H.; Schiebe, D. (Ruhrgas A.G., Essen (Germany, F.R.). Projektberatung). *HLH. Z. Heiz., Lueftung, Klim., Haustech.;* **27**: No. 7, 256-263(Jul 1976). (In German).

5 figs.; 3 tabs.; 5 refs.

A newly discovered thermal efficiency apparatus in which the greatest part of the calorific value (Hsub(o)) of the burning fuel is utilized. Thus the possibility exists of substantially improving the ulilization of energy in comparison with customary methods. A model design is described and the results of the research are reported.

24299 Zinc in the water-steam cycle. Bursik, A. (Grosskraftwerk Mannheim A.G. (Germany, F.R.)); Heimsch, R.; Pfau, B. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Verfahrenstechnik und Dampfkesselwesen). *Energie;* **28**: No. 8, 241-242(Aug 1976). (In German).

2 figs.; 2 tabs.; 20 refs.

A survey is given of studies to explain the occurence of zinc in the water-steam cycle of a power plant. Zinc contents in the corrosion protective coatings formed of evaporation pipes from forced circulation boilers were thus determined, e.g., by means of electron beam microanalysis. Furthermore, zinc is found in suspended corrosion products and in dissolved form in the condensate. All of the hitherto performed investigations have, however, not been able to give a clear picture of the behavior of zinc or of the zinc compounds in the whole cycle. One hopes by specific test studies in a pilot plant to be able to explain further problems in the problem cycle.

24300 Main trends in the development of boiler engineering for the near future. Dobrokhotov, V.I. *Therm. Eng. (USSR) (Engl. Transl.);* **22**: No. 9, 1-4(Sep 1976).

Translated from Teploenergetika; 22: No. 9, 2-4(Sep 1976).

Progress during the period from 1970 to 1975 in the development of power plant boiler equipment in the USSR is reviewed. The design, operation, and performance of steam generators at specific power plants are discussed. Engineering solutions to boiler failures and to improved pollution control and fuel combustion efficiency are described. (LCL)

24301 Scientific research undertakings for developing steam generators for thermal power stations. Petrosyan, R.A. *Therm. Eng. (USSR) (Engl. Transl.);* **22**: No. 9, 5-11(Sep 1976).

Translated from Teploenergetika; 22: No. 9, 4-9(Sep 1976).

USSR programs for improving the design, construction, operation, and performance of high-capacity, efficient steam generators which will be required in an expanding system of fossil-fuel power plants are described. (LCL)

24302 Demands made on steam generators for high-capacity generating units. Tyurin, P.Ya. *Therm. Eng. (USSR) (Engl. Transl.);* **22**: No. 9, 12-15(Sep 1976).

Translated from Teploenergetika; 22: No. 9, 9-12(Sep 1976).

The factors which must be considered in developing reliable steam generators for power plants of increasing capacity, e.g., 300 MW, are discussed. These factors include steam generator design, materials of construction, load factors, operating conditions, furnace design and operation, combustion equipment, fuel forms, and heat transfer equipment. (LCL)

24303 Analysis of the systems of removing flue gases from heat and power stations. Rikhter, L.A.; Kormilitsyn, V.I. (Moscow Power Inst.). *Therm. Eng. (USSR) (Engl. Transl.);* **22**: No. 9, 30-36(Sep 1976).

Translated from Teploenergetika; 22: No. 9, 23-28(Sep 1976).

The design, arrangement, and cost of chimneys or stacks for removing flue gases from fossil-fuel power plants are examined and compared. It is concluded that for high-capacity power plants multiflue chimneys with a greater length of external gas passes should be used. (LCL)

24304 Nonlinear model of a steam generator of a thermal power station with distributed parameters and radiant heat supply. Frenkel, A.Ya.; Maksimova, L.L. *Therm. Eng. (USSR) (Engl. Transl.);* **22**: No. 9, 47-53(Sep 1976).

Translated from Teploenergetika; 22: No. 9, 41-46(Sep 1976).

The problem of construction of nonlinear model of thermal channels of the radiant section of steam generator is discussed with allowance for the distribution of parameters over its length. In connection with the fact that the rate of the processes for the temperature channels is considerably lower than the rate of the processes for the pressure and flowrate channels, the pressure and flowrate channels are singled out as an individual element and are not considered.

24305 High-tension igniter for large natural gas burners in the Moorburg power station. Schenkenberg, H. (Mitarbeiter der Hamburgischen Electricitaets-Werke AG, Hamburg). *Brennst.-Waerme-Kraft;* **28**: No. 9, 347-351(Sep 1976). (In German).

The power station Moorburg consists of two 500 MW units with natural gas and natural gas/heavy oil firing. At the planning stage of the power station, sufficient experience was not available for the combustion of natural gas with high-tension igniters on large burners with a thermal output of 260 GJ/h. The tests carried out on Unit 1 have shown that combustion of the main fuel, natural gas, is possible, even with burners of this magnitude and the high-tension ignition plant. The layout of the power station, details of the natural gas/fuel oil burners, and of the high-tension ignition plant are described. In a comparison, the systems "gas-electric ignition burner" and "high-tension igniter" are explained with respect to the equipment and function. Information on adjusting and running of the tests is included.

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 24985

ECONOMICS

REFER ALSO TO CITATION(S) 24233

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 23957, 23958, 23959, 23960, 23961, 24886, 25298, 25308, 25482

THERMAL EFFLUENTS

REFER ALSO TO CITATION(S) 24884

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

REFER ALSO TO CITATION(S) 24986

24306 Formation of oxides of nitrogen in gas/oil-fired boilers. Efendiev, T.B. *Therm. Eng. (USSR) (Engl. Transl.);* **22**: No. 9, 25-29(Sep 1976).

Translated from Teploenergetika; 22: No. 9, 20-23(Sep 1976).

The mechanisms whereby toxic nitrogen oxides are formed when fossil fuels are burned are discussed. These oxides result from the oxidation of the nitrogen of the air and of the fuel. The nitrogen in the fuel is primarily in the compounds that are easily decomposed on heating and actively enters into reaction with the oxygen. Nitrogen in the form N_2 is difficult to oxidize, but with high temperature combustion of fuel its role in the processes of generating nitrogen oxides is considerable. A method is presented for calculating the amount of NO formed during combustion of fossil fuels. (RCK)

24307 Optimization of daily course of active load in interconnected operation. Okorov, W.R.; Dorrer, V.M. (Leningradskij Politekhnicheskij Inst. (USSR)). *Arch. Energiewirtsch.;* **30**: No. 9, 794-800(Sep 1976). (In German).

3 figs.; 1 tab.; 6 refs. Translated from Russian: K voprosuob optimizacii sutocnogo rezima eletrotechniceskoj systemy po aktivnoj nagruzke. Also published in Izv. Vyssh. Uchebn. Zaved., Ehnerg. (1976) v. 19(2) p. 3-7.

A reduction of the sulfur and nitrogen oxid content in the environment of thermal power plants near the ground can be achieved by various means - e.g. by limiting the amount of harmful substances emitted from the thermal power plants by means of a sensible load distribution among the power plants operating with various fuels. A method is described to consider the emission of harmful material within the framework of the daily interconnected operation. The method of so-called multi-purpose optimization is applied to solve the problems.

24308 Simultaneous removal of nitrogen oxides and sulfur oxides from combustion gases. Clay, D.T.; Lynn, S. (to Energy Research and Development Administration). US Patent 3,987,146. 19 Oct 1976. Filed date 7 Aug 1975. 12p.

A process for the simultaneous removal of sulfur oxides and nitrogen oxides from power plant stack gases comprising contacting the stack gases with a supported iron oxide catalyst/absorbent in the presence of sufficient reducing agent selected from the group consisting of carbon monoxide, hydrogen, and mixtures thereof, to provide a net reducing atmosphere in the SO/sub x//NO/sub x/ removal zone. The sulfur oxides are removed by absorption substantially as iron sulfide, and nitrogen oxides are removed by catalytic reduction to nitrogen and ammonia. The spent iron oxide catalyst/absorbent is regenerated by oxidation and is recycled to the contacting zone. Sulfur dioxide is also produced during regeneration and can be utilized in the production of sulfuric acid and/or sulfur.

SITE SELECTION AND LAND USE

REFER ALSO TO CITATION(S) 24295, 24866, 24881, 24883, 24884, 24885, 24889, 24890, 24891, 24915

POWER TRANSMISSION AND DISTRIBUTION

REFER ALSO TO CITATION(S) 25233, 25322

24309 (EPRI-EL—284) Fundamental investigation of arc interruption in gas flows. Final report. Frind, G.; Kinsinger, R.E.; Miller, R.D.; Nagamatsu, H.T.; Noeske, H.O. (General Electric Co., Schenectady, N.Y. (USA)). Jan 1977. 251p. Dep. NTIS $9.00.

Work on the problem of early, or thermal, recovery of gas blast interrupters is reported. The objective of this work is to obtain a quantitative understanding of the physical and aerodynamic processes important for the optimization of such apparatus. In investigations of model testing techniques, recovery speed (RRRV) was found to be completely independent of power frequency over a wide range as long as nozzle blocking and metallic electrode vapor contamination effects are avoided. In investigations of nozzle and electrode geometry, a sharply defined optimal position was found for the upstream electrode with respect to the nozzle throat. Correlations were established between RRRV and features of the flow field at various electrode positions. A diffuse arc section, contributing very little to the recovery speed, was found at the downstream end of nozzles in which large divergence angles and/or low nozzle pressure ratios led to separation of the flow from the wall and associated internal shock waves. Gases and gas mixtures which have thermal recovery speeds nearly as fast as that of SF_6 were identified. Such gas mixtures, particularly those with SF_6, permit gaining an advantage over pure SF_6 by operation at higher total pressure. A simple theory which indicates the relative recovery speed of gases based on explicit properties of the gas molecular structure was developed. Collectively, the new information holds promise for significant improvements in the thermal interruption speed of gas blast interrupters.

24310 (ERDA-tr—233) Certain questions of automating the design of regional substations. Myslin, D.A. Translated from *Izv. Akad. Nauk SSSR, Energ. Transp.;* No. 5, 68-73(1973). 10p. Dep. NTIS $3.50.

The possibilities of using the computer to resolve basic problems of designing regional substations are examined, i.e., the selection of the area, choice of the primary circuit of electrical connections, and outfitting the substations. Descriptions are given of mathematical models of design and the conditions necessary for the further development of models and their realization in the form of algorithms and programs are determined.

24311 Nodal analysis of power systems. Dimo, P. Forest Grove, OR; International Scholarly Book Services, Inc. (1975). 290p. $30.00.

Translated from French by R. Georgescu.

Nodal analysis is an original method of studying power system states. By transforming the network with the help of computers, simple standardized models called REI (radial, equivalent, independent) are obtained for the whole system, for part of it, or only for a node. Models have a very low number of nodes as compared to the real analyzed network. To REI models for a node, a standardized diagram is also associated which provides information on the structure and state of the network seen from the respective node. The researcher who has assimilated the proposed concepts can always examine the same simple and standardized model (REI models), irrespective of the complexity and extent of the real network. (LCL)

24312 Power circuit breaker theory and design. Flurschein, C.H. (ed.). Forest Grove, OR; International Scholarly Book Services, Inc. (1975). 571p. $65.00.

An analysis is presented of the theoretical and practical problems in circuit breaker design. Chapters are included on: development of different types of circuit breakers (CB); physics of CB arcs, network switching conditions; oil, air-break, air-blast, SF_6, and vacuum CB's; special switching systems; CB specification and testing; design criteria; insulation requirements; and cost effective design. A subject index is provided. (LCL)

24313 Peak load control energy saving and cycling system. Burch, J. (to Controlled Energy Systems Co.). US Patent 3,987,308. 19 Oct 1976. Filed date 16 Jun 1975. 8p.

A control system for limiting peak load demand and/or saving electrical energy by cycling the individual loads within an electrical distribution system is described. Electrical power usage in a distribution system is continuously monitored and compared to a pre-set limit. Loads can be added and cycled according to a limit set by the operator. Loads can also be dropped in response to a signal proportional to the electrical power usage in a distribution system within limits defined by the operator.

AC SYSTEMS, EHV AND UHV

REFER ALSO TO CITATION(S) 24295, 24882

24314 (EPRI-EL—363) Underground cable fault location: a handbook to TD-153. Final report. Deltenre, R.W.; Schwarz, J.J.; Wagnon, H.J. (Bdm Corp., El Paso, Tex. (USA)). Jan 1977. 71p. Dep. NTIS $4.50.

A handbook, designed to serve as a reference document to guide utility operations personnel in the selection and use of fault location equipment on underground power cables, is described. The principal emphasis is directed toward distribution cables but transmission cables are also considered in pertinent instances. The contents are organized into three chapters and an appendix: Ch. I provides a set of pertinent definitions for terms that are used throughout the text. Ch. II is intended for general reference. It identifies and describes seven generic types of fault location equipment. Ch. III presents an approach for the selection of a specific fault locator. Two selection procedures are presented. The first procedure treats the initial equipment purchase. The second procedure treats the selection of the equipment best suited to a particular fault. App. A presents a summary of the available fault location equipment including available specifications.

24315 Long-distance electrical transmission between the V.I. Lenin Hydroelectric Station and Moscow. Nekrasov, A.M.; Rokotyan (eds.). Forest Grove, OR; International Scholarly Book Services, Inc. (1965). 687p. $20.00.

Translated from Russian by P. Boltiansky.

The design, construction, performance testing, operation, and maintenance of the 400 kV power transmission system between the V.I. Lenin hydroelectric power plant and Moscow are discussed in 34 separate chapters.

DC SYSTEMS

REFER ALSO TO CITATION(S) 24882, 25683

24316 **D-C transmission in power systems.** Neiman, L.R.; Glinternik, S.R.; Emel'yanov, A.V.; Novitskii, V.G. (eds.). Forest Grove, OR; International Scholarly Book Services, Inc. (1967). 336p.

Translated from Russian by IPST Staff.

This text on DC power transmission includes information on the development and use of DC systems, operation of equipment such as converters and capacitors in transmission circuits, the stability of DC systems and the influence of such systems on the stability of associated AC systems, and methods for increasing the capacity and reliability of DC systems. A bibliography of 166 items is provided. (LCL)

SUPERCONDUCTING AND CRYOGENIC SYSTEMS

24317 (EPRI-EL—329) **Superconducting fault current limiter. Final report.** Gray, K.E.; Fowler, D.E. (Argonne National Lab., Ill. (USA)). Dec 1976. 43p. Dep. NTIS $4.00.

The use of a superconducting element as the active part of a fault current limiter for the power utilities is considered. Such a device is technically feasible over a wide range of parameters for the required electrical power source and material properties of the superconductors available. Limiting is achieved by driving the superconductor into its resistive state and commuting the current into a shunt resistor. For a three phase, 145 KV (RMS), 2 KA (RMS) line, the total cost excluding installation in the power system and shunt resistor is approximately $300,000. The specific advantages and disadvantages are indicated, as well as the outstanding problems to be tackled next.

24318 (LA—6607-PR) **LASL Nb_3Ge conductor development. Fourth quarterly progress report, July 1—September 30, 1976.** Maley, M.P. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Dec 1976. Contract W-7405-ENG-36. 19p. Dep. NTIS $3.50.

The fourth quarterly progress report of the Los Alamos Scientific Laboratory program to develop Nb_3Ge as a superconductor with potential applications to superconducting power transmission lines covers the period July 1, 1976—September 30, 1976. The temperature dependencies of the critical current density J/sub c/, the ac losses and the surface shielding current, Δsigma were studied on a large number of samples. A nearly universal behavior for J/sub c/(T), J/sub c/(T) = J/sub c/(0) [1-(T/T/sub c/*)^2], was followed by the majority of the samples. Optimization of J/sub c/(0) was found to depend strongly on the concentration of Nb_3Ge_3, which appears to be providing the primary pinning centers. Simultaneous optimization of T/sub c/* is equally important.

24319 (LA-UR—77-99) **Design of multifilamentray Nb_3Sn superconductor tailored to the requirements of a dc superconducting power transmission line.** Laquer, H.L. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 13p. (CONF-761136—2). Dep. NTIS $3.50.

From ASM conference on manufacture of superconducting materials; Port Chester, New York, United States of America (USA) (8 Nov 1976).

There are at least four fundamentally different layouts for Cu-stabilized multifilamentary Nb_3Sn superconductors. Multiple stacking further increases the possible permutations and combinations. The basic designs with respect to compound formation, stability, reduction of current transfer resistances, flexibility and wire strain are analyzed. As a result, a very limited number of geometries for the conductor that will be suitable for use in the subcables of a dc superconducting power transmission line operating in the 10 to 14°K range and at the relatively low self-fields of 0.2 to 0.6 T are specified.

NUCLEAR POWER PLANTS

REFER ALSO TO CITATION(S) 24896, 25242

24320 (TID—8200-R35) **Nuclear reactors built, being built, or planned in the United States as of December 31, 1976.** (Energy Research and Development Administration, Oak Ridge, Tenn. (USA). Technical Information Center). Feb 1977. 44p. Dep. NTIS $4.00.

A compilation is presented which contains unclassified information about facilities built, being built, or planned in the United States for domestic use or export as of June 30, 1976, which are capable of sustaining a nuclear chain reaction. Information is categorized by primary function or purpose.

24321 **Power reactor for radiation-chemistry processes and refinement.** Krasin, A.K.; Salamatov, I.I.; Litvinenko, B.A.; Ananich, P.I.; Kazazyan, V.G.; Malimonova, L.M. (AN Belorusskoj SSR, Minsk. Inst. Yadernoj Ehnergetiki). *Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk;* No. 1, 5-7(1975). (In Russian).

Fundamental proposals are set out for the use of atomic reactors in radiation chemistry as sources of eta and γ radiation. Their advantages and disadvantages are examined from the point of view of the simultaneous production of electrical energy and the production and purification of chemical products. It was shown that for the radiative chemical synthesis of substances under irradiation, the most promising approach would seem to be to use a chemical reagent as a moderator in the active zone and reflector of the reactor. For the purposes specified, a vessel reactor was chosen whose active zone is located in a steel tank with channels for the HTF filled with a reagent. The heat transfer medium was boiling water under a pressure of 70 atm; maximum heat capacity when using the transportable steel vessel at 70 atm. was determined to be 250 MW; radiation capacity for irradiation was 35 MW for an average absorbed dose of 2 10 eV/cm sec. The estimated prime cost of the radiation energy was about 2 kopecks/kWH. Proposals like these should stimulate the search for radiochemical processes using the eta and γ radiation energy of reactors.

24322 **Materials and energy resources.** Rugby; I. Chem. E. Services for the Institution of Chemical Engineers (1976). 43p.p.

Price Pound5.00.

The Working Party has tried to assess the problems likely to stem from future scarcity of a number of important materials and how these interact with the simultaneous depletion of energy resources. The report examines in detail the likely areas of shortages, and their economic, social and political implications, and suggests the various choices for preventive or corrective action. In its recommendations it has delineated areas not only for research but for action by government and by professional and other bodies. The need is forseen for a nuclear power programme of possibly 35 GW(e) by the end of the century part of which could be from fast breeders. Uranium supplies would appear to be adequate only if fast breeders become available. Nuclear fusion is potentially a very large energy source but only for the distant future.

24323 **Nuclear power influence on the development of engineering.** Ablewicz, Z.; Loiko, J. (Biuro Studiow i Projektow 'Energoprojekt', Warsaw (Poland)). *Inz. Budownictwo;* **33**: No. 7-8, 297-302(1976). (In Polish).

On the background of the development trends of the nuclear power, its fabourable influence on the progress in building is indicated. The most characteristic problems appearing in this branch of techniques are discussed.

24324 **Management of large high technology projects.** Peddie, R.A. (Central Electricity Generating Board, London (UK)). *Electron. Power;* **22**: No. 7, 419-422(Jul 1976).

The design and construction of a modern commercial power station is a very large undertaking. Such projects cost between Pound100 million and Pound1000 million, and the economic pressure to reduce first cost and improve thermal efficiency and manpower utilisation has led to power stations becoming very large and extremely complex with many of their design features at the very limit of current technology. As their lead times are invariably longer than the rate of change of technology, commitment to technological advances has often to be made before significant operating experience has been obtained. This is not wrong in itself but it means that very sophisticated management is required to produce reliable plant.

24325 **DAtF-KTG reactor conference in Duesseldorf.** Karwat, H. (Technische Univ. Muenchen, Garching (F.R. Germany). Lab. fuer Reaktorregelung und Anlagensicherung); Steinbock, L. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Material- und Festkoerperforschung); Kalkoffen, F. (Babcock - Brown Boveri Reaktor G.m.b.H., Mannheim (F.R. Germany)); Modemann, G.; Strickmann, G.; Winske, P. (Technische Hochschule Aachen (F.R. Germany). Inst. fuer Elektrische Anlagen und Energiewirtschaft). *Atomwirtsch., Atomtech.;* **21**: No. 8, 427-434(Aug 1976). (In German).

From Reactor meeting; Duesseldorf, F.R. Germany (30 Mar 1976).

2 figs.; 3 refs.

A compact survey is given of the lectures held on the occasion of the 8th Reactor Conference. Papers were presented within four sections: 1) reactor lay-out and experiments, 2) fuel elements and the fuel cycle, 3) design, construction, and operation of nuclear facilities and their components, and 4) reactor concepts and questions of economy. Interesting singular developments as well as broad lines of development are reported on in this context.

24326 Better operating data helps improve productivity. Lapides, M.E. (Electric Power Research Inst., Palo Alto, Calif. (USA)). *Nucl. Eng. Int.;* 21: No. 249, 53-55(Oct 1976).

The starting point for improvements in nuclear power station productivity must be comprehensive and comparable information on the operating performance of components and the impact of failures on outages. Several organisations in the U.S. are working on suitable data-base definitions which are summarised. Representative outage figures for U.S. nuclear plant are discussed. Figures are quoted for forced outages of turbines and for valve outage causes.

24327 Some facts on nuclear power expansion. Lingjaerde, R.O. (Institutt for Atomenergi, Kjeller (Norway)). *Ingenioer-nytt;* 12: No. 87, 2,15(29 Oct 1976). (In Norwegian).

A brief survey.

A brief survey is given of installed and planned nuclear power in the USA, USSR, France, Germany, Sweden and Denmark. Plans in Iran, Nigeria and South Africa are also mentioned, as are a number of developing countries. Certain reactor types are briefly discussed, including PWR, SGHWR, CANDU, HTGRand FBR types.

24328 Breeder reactors and coal central in industrialised nations' energy research. *Ingenioer-nytt;* 12: No. 89, 14-15(5 Nov 1976). (In Norwegian).

Summary of a Swedish report.

A report published by Delegationen foer Eenergiforskning (DFE) in Sweden is summarised. The report discusses R and D in the energy sector in seven industrialised nations, USA, USSR, Japan, Federal Republic of Germany, UK, Canada and France. The greatest amount is spent on nuclear fuels, principally on breeder reactors. After that fossil fuels, and here mainly coal, is the object of most work. Nuclear and fossil fuels account for about 80% of the world's energy research. Fusion research accounts for 5%. Allocations for energy conservation are small, in the USA only 3%, in the FRG 1%, in Canada 7% and in France 10%. Here Sweden is a clear exception with 40%. Research funding relative to energy consumption in Sweden is at about the same level as in Japan and Canada, but much lower than in France, the UK, USA, or Germany.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 24480, 24680, 24692, 24731, 24738, 24748, 24749, 24752, 24753, 24754, 24794, 24823, 24824, 24835

24329 (CENPD—177) **CEDNBR: a computer code for transient thermal margin analysis of a reactor core.** Shesler, A.T.; Lehmann, C.R. (Combustion Engineering, Inc., Windsor, Conn. (USA)). Sep 1976. vp. Combustion Engineering, Inc., Windsor, CT.

The report describes the CEDNBR computer code. This code was developed for the transient thermal analysis of a pressurized water reactor core or a critical heat flux test. Included are the code structure, conservation equations, and correlations utilized by CEDNBR. The methods of modelling a reactor core and hot channel and a CHF test are presented. Comparisons of CEDNBR calculations are made with both empirical pressure loss data and simulated loss of flow test data. The code solves the one-dimensional conservation of mass, energy, and momentum equations and the equation of state for the fluid for either steady-state or transient conditions. Tabular time dependent functions of inlet temperatures, pressure, mass velocity, axial heat flux distributions, normalized heat flux, radial peaking factors, and incremental mixing factors are required input to the code. Transient effects are included in the calculation of enthalpy rise and fluid properties. The Departure from Nucleate Boiling Ratio (DNBR) is calculated by applying a Critical Heat Flux (CHF) correlation to the computed local fluid properties. A code user's guide is provided for preparing input to the code. In addition, descriptions of the sub-routines used by CEDNBR are given.

24330 (MK—1-02-012(Rev.2)) **Description of short term program plant unique torus support systems and attached piping analysis.** (Nutech, San Jose, Calif. (USA)). Jun 1976. 30p. TIC.

Recently identified pool swell loads have been the subject of detailed studies by the General Electric Company (GE) acting on behalf of the Mark I Owners Group. Each utility with an operating plant plans to conduct a plant unique analysis of the torus support system and external piping attached to the torus. The purpose of the document presented is to describe what is being planned as a minimum for these plant unique analyses. The methods of analysis and the loadings which will be used are described briefly. A description is also presented of the evaluation criteria which will be used to determine if a plant unique action plan need be developed and discussed with the NRC as a basis for continued operation during the long term program. The evaluation criteria described may require the determination of the failure loads for the various structural elements in the load paths. An appendix has been prepared by Teledyne Materials Research to provide some specific methods which may be used to determine these failure loads.

24331 (TREE-NUREG—1022) **Postirradiation examination results for the Irradiation Effects Scoping Test 2.** Mehner, A.S. (EG and G Idaho, Inc., Idaho Falls (USA)). Jan 1977. Contract EY-76-C-07-1570. 71p. Dep. NTIS $5.00.

The postirradiation examination results are reported for two rods from the second scoping test (IE-ST-2) of the Nuclear Regulatory Commission Irradiation Effects Program. The rods were irradiated in the in-pile test loop of the Power Burst Facility at the Idaho National Engineering Laboratory. Rod IE-005 was fabricated from fresh fuel and cladding previously irradiated in the Saxton Reactor. Rod IE-006, fabricated from fresh fuel and unirradiated cladding, was equipped with six developmental cladding surface thermocouples. The rods were preconditioned, power ramped, and then subjected to film boiling operation. The performance of the rods and the developmental thermocouples are evaluated from the post irradiation examination results. The effects of prior irradiation damage in cladding are discussed in relation to fuel rod behavior during a power ramp and subsequent film boiling operation.

24332 Fuel assembly arrangement in nuclear reactors. Hoechel, J.; Schwarzwaelder, R. (to Licentia Patent-Verwaltungs-G.m.b.H.). German(FRG) Patent 1,265,881/C/. 8 Aug 1974. 1p. (In German).

1 fig.

For centrifugation of the coolant water, screw surface shaped baffles are arranged around the fuel rods with coolant flow from below, e.g. of a boiling water reactor. There are gaps between the baffles; the gaps of all fuel rods lie in the same plane. In order to prevent friction corrosion, the baffles are mounted by means of spring clamps or wire grids in such a manner that there is enough clearance between them and the fuel rod surfaces. A sufficient turbulence is thus achieved and at the same time structural material is saved.

24333 Spherical nuclear reactor containment. Ullrich, W.; Pflug, V.; Mueller, W.; Kuschel, D. (to Licentia Patent-Verwaltungs-G.m.b.H.). German(FRG) Patent 2,134,420/C/. 3 Oct 1974. 2p. (In German).

6 figs.

Around the spherical pressure vessel a water pool is toroidally arranged as a pressure suppression chamber. At the lower part of the sphere a cylindrical auxiliary vessel is mounted in order to be able to remote the control rod drives. Sphere and auxiliary vessel are made of steel. The sphere is anchored in a concrete foundation and terminates there as auxiliary vessel. Joining of the two parts is achieved by connecting the sphere with the upper ring of the auxiliary vessel. The transition may also be accomplished, by conical design of the metal vessel or by means of conical segments. Support is given by the concrete foundation.

24334 Fatigue crack extension in nozzle junctions; comparison of analytical approximations with experimental data. Broekhoven, M.J.G; van de Ruijtenbeek, M.G. (Delft Univ. of Technology (Netherlands). Lab. for Thermal Power and Nuclear Engineering). pp 12p, Paper G4/7 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The fracture mechanics based stress intensity factor (K-factor) concept has obtained wide-spread acceptance as a tool for quantitative analysis of both fatigue crack growth and instable fracture. The high local stresses associated with discontinuties such as perforations (pipe plates) and cylinder-to-cylinder or cylinder-to-sphere connections enhance crack initiation and extension. Such cracks generally develop in the shape of quarter ellipses. Due to the complexity of such crack configurations a fully 3-D finite element treatment seems mandatory to obtain solutions, but the associated high computation costs makes this procedure extremely expensive for standard design procedures. By contrast, analytical approximations, allowing for the application of available analytical solutions by strongly schematizing the complex geometry and stress distribution, are cheap, but generally unreliable, unless checked with accurate experimental and/or finite element data. The present study discusses the applicability of various simple analytical approximations, some of which have been advocated in literature, and of a specially developed semi-analytical procedure, by comparing results with experimental data.

24335 Influence of the assembly configuration on the flow induced vibrations of BWR fuel elements. Carmignani, C.; Manfredi, E.; Reale, S. (Pisa Univ. (Italy). Istituto di Impianti Nucleari); Cerretii, P.; Frederico, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). pp D2/8 1-10 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

One of the most important design features of a BWR (and PWR) fuel element is the assembly of the rod bundle itself, which is strongly influenced by the position, number, and design of the spacer grids. A research program to study systematically the influence of the assembly configurations on the vibrations of a typical BWR fuel element has been carried out. This work consisted of a series of test runs carried out by means of a circulating water test loop realized for this purpose at Scalbatraio Laboratory of Istituto di Impianti Nucleari. Power spectral density and cross correlation functions have been determined and phase and coherence information obtained which have been used to evaluate vibration modes and root mean square amplitudes for each test configuration at the various flow velocities. These results are compared with the prediction of the vibration behaviour of the fuel element, obtained from the available correlations given by other researchers, as well as from a new correlation formula devised for this scope.

24336 Research on PCPV for BWR - physical model as design tool - main results. Fumagalli, E.; Verdelli, G. (Istituto Sperimentale Modelli e Strutture, Bergamo, Italy). pp H3/5 1-14 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

A series of tests on physical models is being carried out as a part of a research programme with the aim to design a thin -walled PCPV for BWR. The physical model, together with the mathematical model and the rheological model of the materials, is intended as a meaningful design tool. The mathematical model covers the overall structure design phase and the linear behaviour. The physical model supplies global information to be compared with the results of the mathematical model and also supplies a number of data as the non-linear behaviour up to failure and local conditions (penetration area etc.) are concerned. The paper describes the model and illustrates the main results, underlining the different behaviour of the upper and bottom slabs up to collapse.

24337 Analytical and experimental vibration analysis of BWR pressure vessel internals. Krutzik, N.; Schad, O. (Kraftwerk Union A.G., Offenbach (Germany, F.R.). Hauptbereich Reaktortechnik). pp F1/1 1-19 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975). (In German)

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The report attempts to evaluate the validity as well as quality of several analytical methods in the light of presently available experimental data for the internals of pressure vessels of boiling-water-reactor-types. The experimental checks were performed after the numerical analysis was completed and showed the accuracy of the numerical results. The analytical investigations were done by finite element programmes - 2-dimensional as well as 3-dimensional, where the effect of the mass distribution with parts of virtual masses on the dynamic response could be studied in depth. The experimental data were collected at various plants and with different mass correlations. Besides evaluating the dynamic characteristics of the components, tests were also performed to evaluate the vibrations of the pressure vessel relative to the main structure. After analysing extensive recorded data much better understanding of the response under a variety of loading- and boundary conditions could be gained. The comparison of the results of analytical studies with the experimental results made a broad qualitative evaluation possible.

24338 Irradiation swelling, creep, and stress analysis of LWR fuel elements, computer code ISUNE-2. Ma, B.M. (Iowa State Univ. of Science and Technology, Ames (USA). Engineering Research Inst.). pp D1/3 1-19 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The irradiation swelling, creep, and stress analysis of light water reactor (LWR) oxide (UO_2) fuel elements is analyzed. The analysis is based on the basic physical and mathematical assumptions and the experimental data of the fuel and cladding materials. In the analysis, the nuclear, physical, metallurgical, and thermo-mechanical properties of the fuel and cladding materials under irradiation environment are examined carefully. The objectives of the paper are mainly (1) to formulate and carry out the irradiation swelling, irradiation creep, and stress analysis of fuel element for LWR power reactors and (2) to develop a computer code which will facilitate the computations for fuel element design, safety analysis, and economic optimization of the power reactors.

24339 Crack propagation characteristics in the nozzle of a pressure vessel steel model of light water reactor. Miyazono, S.; Shibata, K. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). pp G4/8 1-11 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

In light water reactor technology, it is a very important subject that the crack initiation life and propagation behaviour is experimentally and theoretically investigated at the nozzles attached to the pressure vessel, where the maximum circumferential stresses are caused at the inner corner surface by internal pressure. The paper describes experimental results which were obtained by measuring the propagation length from an artificial crack in the inner corner surface of the nozzles using an electrical resistance method and crack gage, when internal pressure was cyclically loaded to a steel model of reactor pressure vessels. In order to investigate the effects of the shape of nozzles and artificial cracks on the crack initiation life and propagation rate, in the experiment four different shapes of nozzles (diameter ratio of nozzle to shell were 0.045, 0.075, 0.10 and 0.15) were attached to the pressure vessel model and two different types of artificial cracks (the shape of each tip was curved (A-type) or straight (B-type)) perpendicular to the direction of the maximum circumferential stresses were machined at the inner corner surface of each nozzle. From the experiment, it was apparent that the crack initiation life for the crack tip of A-type was shorter than for that of B-type in every nozzle and for the crack initiation life at each inner surface of nozzle and shell there was not any distinct difference between A and B.

24340 Theoretical and experimental studies for optimization of PCRV top closures. Ottosen, N.S.; Andersen, S.I. (Danish Atomic Energy Commission, Risoe. Research Establishment). pp H3/6 1-13 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Within the framework of the Scandinavian development work on prestressed concrete pressure vessels for boiling water reactors, the influence of different parameters upon the ultimate load and failure of the top closure is investigated by model experiments and comparative calculations. The very high ultimate load capacity of the original reference design had been demonstrated in a previous work. Additional studies on the potential reduction of the closure dimensions have therfore been carried out with a view to minimize total costs. The paper presents the results from the remaining part of the parameter study and the preparations for the verification of an optimized design.

24341 Finite element structural analysis of a PCPV for a BWR. Riccioni, R.; Robutti, G. (ISMES, Instituto Sperimentale Modelli e Strutture, Bergamo, Italy); Scotto, F.L. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). pp H2/7 1-14 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

An interactive method has been adopted at I.S.M.E.S. in undertaking a design of a prestressed concrete pressure vessel for a boiling water reactor. By means of an immediate and continuous reading of automatic graphic outputs (displacements, stresses, and local safety factors(, such a procedure has made it possible to identify the necessary improvements for the optimization of the structure under consideration. The structure involved consists mainly of a cylinder of constant thickness closed at the lower end with a bottom slab, and at the upper end with a removable lid slab.

24342 'Thin walled' concept and a new top lid applied to the Scandinavian PCRV for a boiling water reactor. Scotto, F.L. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). pp H3/4 1-9 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Research is being carried out under an agreement between AB ATOMENERGI of Sweden and ENEL (Ente Nazionale per l'Energia Elettrica) of Italy, for an exchange of information in the field of PCPV for BWR, and takes as a reference the Scandinavian solution as far as the thermal insulation system and the geometry are concerned, proposing new solutions of the prestressed concrete structure (namely the author's concept of thin walls and a new concept of top lid). The proposed top lid sealing system solution is in line with the one adopted for the conventional steel pressure vessel enclosures: furthermore the prestressed concrete lid is restricted to the prestressed concrete structure to form a continuous concrete structure, in line with the PCPV conventional solutions for gas reactors.

24343 Ultrasonic resin cleaner. Nomi, M.; Shimogori, M.; Miyazoe, T. (Ebara Mfg. Co. Ltd., Tokyo (Japan)). *Ehara Jiho;* No. 94, 29-33(Dec 1975). (In Japanese).

In the boiling water reactor, the produced steam is fed directly to the turbine to generate power. This steam is cooled and is cleaned by the condensate demineralizer. However, the iron oxides and hydroxides (referred to as "crud") usually adhere to the ion exchange resin in the condensate demineralizer so strongly that they cannot be easily removed by chemical regeneration. To overcome this difficulty, ultrasonic waves have been tried out to physically clean up the resin beads. The basic experiment has revealed that the crud can be easily removed from the resin surfaces, and the optimum wave frequency for this process has been obtained. Based on a series of basic tests, experimental continuous processing equipment of both small and medium scales were assembled. With these pilot units, the whole process is automatically controlled and the continuous separation of cleaned resin beads from the crud and backwash water is easily achieved. The test results have well proved that this method can be satisfactorily put into practical use to substantially reduce the production of chemical wastes which are difficult to treat.

24344 System for the thermomobile support of a reactor pressure vessel. Harand, E.; Michel, E. (to Kraftwerk Union A.G.). German(FRG) Patent 2,432,001/A/. 15 Jan 1976. 15p. (In German). 6 figs. Available from Dt. Patentamt, Muenchen (FRG).

A device is described for the thermomobile support of a reactor pressure vessel on holding elements of a counter bearing within a rupture safety apparatus surrounding the reactor pressure vessel with a gap.

24345 Nuclear reactor instrumentation. Survey of standards. International recommendations' validity as Swedish standard. Stockholm; Standards Commission (15 Apr 1976). 2p.

This standard gives a survey of norms for nuclear reactor instrumentation. It includes: 1. International recommendations published by International Electrotechnical Commission, IEC, valid as Swedish standard. The recommendations have not been translated into Swedish, but are available in English and French in teh IEC publications. 2. Information on other norms. Listed are standards on nuclear reactor instrumentation in general and instrumentation for BWR-, PWR- and gas cooled graphite moderated reactors.

24346 (ORNL-tr—4274) **Assay of fresh fuel elements of boiling water reactors for their ^{235}U content with an Sb—Be-source.** Baumung, K.; Boehnel, K. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). Jun 1976. Translation by M. Gerrard of KFK—2292. 33p. Dep. NTIS $4.00.

When irradiating an LWR fuel element with neutrons from a Sb—Be-source, the number of fission neutrons is a measure of its content of U-235. It is shown that fission neutrons can be reliably distinguished from the source background by using recoil proportional counters together with proper pulse height discrimination. Investigations of the filling gas suggest a preference for methane over He-4 because of better γ-n-discrimination. Better utilization of the source neutrons is attained by nickel reflectors. A measuring device is described in which the detection probability of fissile material at the various fuel pin positions differs by less than 10 percent from the average. Since the precision depends strongly on the temperature, its effects on the various components of the system were determined. The apparatus described allows a statistical precision of 0.5 percent when measuring a fuel element with 2.5 percent enrichment for 1 hour with a Sb activity of 10 Ci.

24347 Corrosion protection of the condensation chamber in boiling-water reactors. Testing and selection of painting systems. Dunkel, W. (Allgemeine Elektricitaets-Gesellschaft AEG Telefunken, Kassel (Germany, F.R.). Isolier- und Kunststoff-Fabrik); Scholl, K.; Kuschel, D. (Kraftwerk Union A.G., Offenbach (Germany, F.R.)). *At. Strom;* **22**: No. 5, 125-132(Sep 1976). (In German).

18 figs.; 6 refs.

The authors list the requirements for the corrosion protection of the condensation system for boiling-water reactors, and describe the tests and selection criteria. They show that a four-coat tar/epoxy resin painting system with a minimum thickness of 500 μm meets the requirements for temperature stability and purity of water with completely desalinated water. If in a particular case compliance with US tests is required then a three-coat system of the same type having a minimum thickness of 300 up to a maximum of 500 μm also meets the requirements set if the application is carefully carried out.

24348 Ten years of KRB Gundremmingen demonstration power station. Facius, H. von (Kraftwerk Union A.G., Offenbach (Germany, F.R.)); Ettemeyer, R. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen/Guenzburg (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **21**: No. 9;10, 454-457(Sep 1976). (In German).

4 figs.; 1 ref.

In August 1976 the first large nuclear power station in the Federal Republic, the KRB Gundremmingen plant with a net power of 237 MWe, has been in operation ten years. The construction of KRB as a demonstration plant was a major step forward on the way to the economic utilization of nuclear power for German utilities. Design and operation of the plant have decisively influenced the further development of the technology of light water reactors in the Federal Republic. Unlike the Kahl Experimental Nuclear Power Station (VAK), which was a test facility designed to generate experience and to train personnel, the decision to build KRB from the outset was conditional upon the fulfillment of economic criteria. Here are some of the aspects in which KRB has greatly influenced the development of nuclear power station technology: first application of internal steam-water separation instead of a steam drum with a water content of the steam of less than 1%; construction of a reactor buildung with all the necessary safety factors; solution of the corrosion and erosion problems linked with the use of a saturated steam turbine; special measures taken to prevent the turbine from speeding up due to post-evaporation effects after shutdown. Detailed comments are devoted to the subjects of availability, causes of failure and repair work.

24349 Comprehensive approach to in-service inspection. Chockie, L.J.; Clark, J.P.; Hannah, K.J.; Johnson, M.R. (General Electric Co.). *Nucl. Eng. Int.;* **21**: No. 249, 64-67(Oct 1976).

General Electric has developed a broad in-service inspection programme for its BWRs, which meet the ASME Code requirements, while eliminating in-service inspection capital investment. The package can include supply of all manpower, materials and equipment for each 10 y contractual period. A description is given of the pressure weld examination system, capable of scanning both circumferential and longitudinal seam welds on exterior vessel walls. The system consists of a trackless vehicle equipped with a scanner and transducer package connected to ultrasonic and guidance instrumentation. The nozzle scanner system is also described.

24350 Fabrication, properties, and irradiation behavior of U/Pu particle fuel for light water reactors. Lahr, H.W.H. (Gelsenberg AG, Karlsruhe, Ger.). *Nucl. Technol.;* **31**: No. 2, 183-190(Nov 1976).

Advantages were offered by particle fuel fabrication using an optimized precipitation method on heavy-metal nitrate solutions from reprocessing plants. This fabrication technology (the vibration compaction of the particles in cladding tubes above all demonstrating its capability of being automated and having relatively small amounts of scrap and wastes) might result in cost savings of more than 30 percent. Irradiation experiments have shown that the use of particle fuel results in advantages that can be anticipated as higher burnups and frequent load cyclings when compared with pellet fuel.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 24331, 24338, 24339, 24344, 24345, 24350, 24480, 24688, 24689, 24697, 24702, 24704, 24731, 24735, 24738, 24752, 24753, 24754, 24756, 24757, 24759, 24760, 24762, 24763, 24764, 24771, 24790, 24794, 24795, 24797, 24819, 24823, 24824, 24826, 24829, 24845, 24849

24351 (BAW—10130) **LYNX2: subchannel thermal-hydraulic analysis program.** (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Oct 1976. 82p. Babcock and Wilcox, Lynchburg, VA.

LYNX2 calculates subchannel conditions by conserving mass, momentum, and energy. Intersubchannel diversion crossflow is determined from transverse pressure differences. The coupled conservation relations for the linked subchannels are iterated to a solution over each calculational increment. Also considered is intersubchannel turbulent interchange. Interbundle diversion crossflow (IBDCF) is incorporated; input IBDCF is interpolated axially to match the position of the calculational increment and is evaluated in the two normal flow directions to match the locations of the edges of the rod and subchannel array. Thus, the edge subchannels transfer mass, energy, and momentum through the periphery of the array by diversion crossflow. Repeated iterations of the conservation relations propagate interbundle effects throughout the rod and subchannel array. LYNX2 has evolved from COBRA but has been modified to accept up to 324 subchannels and 289 fuel rods. The geometry, location, area and gap variations, and hot-channel-factor set of each subchannel may be described, and the geometry, location, radial power factor, and axial flux shape of each fuel rod may be defined. As many as five hot-channel-factor sets may be input, axial heat flux shapes may be defined by five polynomials or four section sets. Ten form loss regions may be modeled using position, length, loss coefficient, and area contraction ratio. Turbulent interchange proportionality factors may be input as a function of quality. Critical heat flux ratios may be calculated using the B and W2 and W-3 correlations.

24352 (WCAP—8763) **New Westinghouse correlation WRB-1 for predicting critical heat flux in rod bundles with mixing vane grids.** Motley, F.E.; Hill, K.W.; Cadek, F.F.; Shefcheck, J. (Westinghouse

Electric Corp., Pittsburgh, Pa. (USA). Nuclear Energy Systems Div.). Jul 1976. vp. Westinghouse Electric Corp., Pittsburgh, PA.

A new critical heat flux (CHF) correlation, based on local fluid conditions, has been developed from Westinghouse rod bundle data. This correlation applies to both 0.422 inch and 0.374 inch rod O.D. geometries. It accounts for typical cell and thimble cell effects, uniform and non-uniform heat flux profiles, variations in rod heated length and in grid spacing. The correlation predicts CHF for 1147 data points with a sample mean and standard deviation of measured-to-predicted heat flux ratio of 1.0043 and 0.0873, respectively. It was concluded that to meet the reactor design criterion the minimum DNBR should be 1.17.

24353 Device ensuring liquid circulation in connecting piping. Strmiska, F.; Buchnickova, Z. Czech Patent 151,859. 15 Jan 1974. 3p. (In Czech).

A method is proposed for securing the circulation of a liquid in the connecting conduit and in the bottom part of the water space of the liquid volume compensator of the primary coolant circuit of a nuclear power plant or of a power and heat plant. The method consists in building an adjustable pressure drop element into the primary coolant circuit, between the connecting pipes. The equipment secures the reliability and operating safety of the primary coolant circuit liquid volume compensation system.

24354 Nuclear power plant with a reactor pressure vessel. Figlhuber, D.; Kastl, H. (to Siemens A.G.). German(FRG) Patent 2,325,388/B/. 1 Aug 1974. 5p. (In German).

2 figs.

With the manipulator, inspections and repairs on the inner surface of the pressure vessel wall of, e.g., twin units and/or PWRs may be carried out. It comprises a mast displaceable with respect to height which is suspended on a travelling crab. On the mast, a vertically movable support is arranged. It carries a horizontal arm which can be extended in longitudinal direction and rotated around its longitudinal axies. On top of the arm the tools or inspection instruments, e.g. ultrasonic head or TV camera, are attached. The support is held by chains or ropes allowing continuous displacement.

24355 Virtual mass effect of water on the intervals of pressurized water reactors. Theory and experimental results. Alibaud, J.G. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). pp vp, Paper F2/4 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24356 Vortex-excited vibration and acoustic phenomena in tube-banks in cross-flow. Bai, D. (Electricite de France, 78 - Chatou. Service Generateurs et Echangeurs de Chaleur Thermiques et Nucleaires). pp 12p, Paper F7/7 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975). (In French)

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Steady cross-flow over tube-arrays can induce both unsteady forces on tubes and acoustic standing waves. These facts become all the more dangerous for the structures as heavy fluid exchangers are developed (e.g. steam generators for pressurized water reactors) and flow velocities increased, specially with the working safety notion which is above the structural failure problems, particularly for nuclear power units. In addition of the three sorts of vibration (due to flow turbulence, vortex shedding and instabilities phenomena) one can have an excited acoustic standing wave, these phenomena coming together or interacting. In this first step, this study analyses the vortex-shedding phenomena, the excitation of an acoustic standing wave and its locking-in, and the unsteady flow induced forces on the tubes. The paper points out results obtained on thirteen test-rig arrangements (in-line or staggered, with unfinned or finned tubes). The study shows that the risks are more important in arrangements with small spacing ratios: acoustic standing waves occur at lower flow speeds, because of the jump in frequency of the Strouhal frequency; in addition, the shedding vortices being perfectly correlated over the whole array, the flow induced forces on the tubes are more severe.

24357 3-D analysis of reactor loop isolation valves. Dietrich, D.E. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). pp 9p, Paper F6/9 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

A full three-dimensional analysis for the design and operational loading conditions was performed on a 29 inch loop isolation valve using the Westinghouse finite element computer code. The 3-D analysis was employed for the valve design in place of utilizing the standard ASME valve design criteria. The valve design employs the design by analysis concept allowed for nuclear class valves.

24358 Collapse of heat exchanger tubes with ovality and simulated defects. Livsey, W.O.; Junejo, A.A. (General Electric Co. Reactor Equipment Ltd., Whetstone (UK)). pp 9p, Paper F7/5 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

An experimental program has been carried out on typical P.W.R. heat exchanger tubing with two objectives; firstly to investigate the collapse pressure of the tubes with varying amounts of initial tube ovality, secondly to simulate tube defects which might be expected to occur during operation. The defects were artificially induced to simulate: 1. Longitudinal tube cracking; 2. fretting at tube supports; 3. erosion; and were produced by means of a 60°V groove machined longitudinally partially through the wall of the tube, spark erosion, and chemical thinning, respectively.

24359 Resonance frequencies of a tubular shell surrounded internally and externally by fluid annuli of variable thickness. Taymans, E.; Goeyse, A. de; Jaumotte, A. (Brussels Univ. (Belgium)); Mathieu, F.; Planquart, J. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). pp F2/12 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24360 Vibration behaviour of PWR reactor internals. Model experiments and analysis. Assedo, R.; Dubourg, M. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)); Livolant, M.; Epstein, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service des Etudes Mecaniques et Thermiques). pp F1;7 1-9 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

In late 1971, the CEA and FRAMATOME decided to undertake a comprehensive joint program of studying the vibration behaviour of PWR internals of the 900 MWe, 50 cycle, 3 loop reactor series being built by FRAMATOME in France. The PWR reactor internals are submitted to several sources of excitation during normal operation. Two main sources of excitation may effect the internals behaviour: the large flow turbulences which could generate various instabilities such as: vortex shedding; the pump pressure fluctuations which could generate acoustic noise in the circuit at frequencies corresponding to shaft speed frequencies or blade passing frequencies, and their respective harmonics. The flow induced vibrations are of complex nature and the approach selected, for this comprehensive program, is semi-empirical and based on both theoretical analysis and experiments on a reduced scale model and full scale internals.

24361 Stress and strain analysis in the plastic fields of a PWR pressure vessel. Chevalier, G.; Clement, G.; Goldstein, S.; Hoffman, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service des Etudes Mecaniques et Thermiques). pp G1/3 1-11 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The pressure vessel of the pressurized water reactor project Champlain has been calculated twice with two different programs of the CEA-SEMT system: the first axisymmetrical and the second on shell elements. The calculations involved the same load diagram and material of the same characteristics represented by the uniaxial traction test on a sample of the steel used for this vessel. An axisymmetrical calculation with the PASTEL program was carried out on a section of the pressure vessel between two inlet points, which means that the structure considered is assumed as cylindrical. A shell element calculation with the TRICO program was carried out on a quarter vessel containing an inlet point of 700 mm diameter. The results obtained with these two CEA programs agree very well. It was possible to show how the plasticity progresses with each pressure step. These two studies enabled the excess overall deformation to be estimated under a load 2.5 times the nominal pressure, this deformation appearing mainly in the cylindrical part of the vessel. It was shown that at such loads no plastic instability occurs.

24362 Nuclear-reactor steam generator. Sfiteler, F.Z.; Donohue, J.P. (to Combustion Engineering, Inc.). French Patent 2,273,349/A/. 17 Mar 1975. 11p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 18 Mar 1974, US.

The invention relates to steam-generators. It deals with an installation in which auxiliary demineralization devices permit to treat a continuous draining flow whenever the steam-generators have leakages between the primary and secondary circuits, the primary circuit being radioactive in view of its circulating through a nuclear-reactor. This can be applied to the steam-generators of nuclear power-stations.

24363 Reactor coolant pumps for nuclear reactors. Harand, E.; Richter, G.; Tschoepel, G. (to Kraftwerk Union A.G.). German(FRG) Patent 2,345,081/A/. 20 Mar 1975. 19p. (In German). 10 figs.

A brake for the pump rotor of a main coolant pump or a shutoff member on the pump is provided in order to prevent excess speeds of the pump rotor. Such excess speeds may occur in PWR type reactors with water at a pressure below, e.g., 150 bars if there is leakage from a coolant line associated with the main coolant pump. As a brake, a centrifugal brake depending upon the pump speed or a brake ring arranged on the pump housing and acting on the pump rotor, which ring would be activated by pressure differentials in the pump, may be used. If the pressure differences between suction and pressure sockets are very small, a controlled hydraulic increase of the pressure force on the brake may also be provided. Furthermore, a turbine brake may be provided. A slide which is automatically movable in closing position along the pump rotor axis is used as a shutoff element. It is of cylindrical configuration and is arranged concentrically with the rotor axis.

24364 Installation for restricting the deleterious effects of an accident in a nuclear power-station. Bukrinsky, A.M.; Matskevich, G.V.; Rzheznikov, J.V.; Sukhov, A.B.; Tatarnikov, V.P.; Berkovich, V.M.; Remzhin, J.N.; Slepnev, L.N.; Sverdlov, A.A.; Karan, V.G. French Patent 2,274,120/A/. 4 Jun 1975. 17p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 5 Jun 1974, SU.

The installation forming the object of the invention is characterized in that the first room and the second room are mutually connected by a duct in which, at the second room entrance, are mounted a non-return valve for preventing the back-flow of the air expelled from the first room, and a condenser in the form of a mixing device, comprising at least one container filled with a cooling liquid and a sheath mounted above said container, the inlet portion of which is immersed in said container so as to form with the walls thereof passages for the admission of the steam-air mixture. The invention can be applied to nuclear power-stations in which the coolant is water at high temperatures and high pressures.

24365 Nuclear fuel element. Aisch, F.W.; Fuchs, H.P.; Knoedler, D.; Steinke, A.; Steven, J. (to Kraftwerk Union A.G.). German(FRG) Patent 2,413,464/A/. 2 Oct 1975. 13p. (In German). 5 figs.

The invention relates to a nuclear fuel element consisting of a multiplicity of fuel rods which are installed by means of spacer grids in a supporting construction with a head piece and a foot piece and rod-shaped elements connecting these. The supporting construction should be very stable especially with regard to a possible accident. According to the invention, the connections between the rod-shaped elements and at least one end piece have elements allowing a relative axial displacement of these parts with respect to each other, in case a predetermined axial pressure limit load of the fuel element is exceeded. This desired separating spot is secured, hooever, in such a way that it is effective in emergency situations, only. The constructional design is described in great detail.

24366 Reactor pressure vessel. Puchelt, M.; Seidelberger, H. (to Kraftwerk Union A.G.). German(FRG) Patent 2,417,601/A/. 23 Oct 1975. 9p. (In German).

3 figs.

An improvement of a detachable duct bolt for multiple measuring cables at the pressure vessel of a nuclear reactor is described which, if necessary allow multiple interchanging of single measuring cables without disturbance. Each measuring cable is soldered in a metal sleeve, these sleeves being welded each to a tube afterwards, which, for its part, is pressed into the cone of a socket piece arranged on the reactor pressure vessel. There are, consequently, three seals, which under suitable design - the tubes, e.g., may be installed like rays on an arched plate - are well controllable and guarantee sealing.

24367 Nuclear reactor vessel surface inspecting technique applying electric resistance probe. Yamaguchi, T.; Enami, K.; Yoshioka, M. (Mitsubishi Heavy Industries Ltd., Tokyo (Japan)). *Mitsubishi Juko Giho;* **12**: No. 6, 713-718(Nov 1975). (In Japanese).

A new technique for inspecting the inner surface of the PWR type nuclear reactor vessel by use of an electric resistance probe is introduced, centering on a data processing system. This system is composed of a mini-computer, a system typewriter, an interface unit, a D-A converter and controller, and X-Y recorder and others. Its functions are judging flaws and making flaw detection maps. In order to judge flaws by flaw detection signals, three kinds of flaw judging methods have been developed. In case there is a flaw, its position and depth are calculated and listed on the system typewriter. The flaw detection maps are expressed in four kinds of modes and they are displayed on the X-Y recorder.

24368 State of development of centripetal ventilators for cooling towers. Petermann, H. pp 157-161 of In Thermische Stroemungsmaschinen. Duesseldorf, Germany, F.R.; VDI (1976). (In German)

From Conference on thermal turbo-engines; Duesseldorf, Germany, F.R. (4 Oct 1976).

9 figs.; 5 refs.

In the nuclear power station at Biblis, the conventional central cooling tower ventilator has been replaced by a large number of smaller axial ventilators arranged on the outer shell of the cooling tower in the air intake region. Tests have been carried out with the aim of finding a practicable blade system for a centripetal cooling tower ventilator. The blower diameter of this model ventilator is about 1 m. Using the model laws, the knowledge gained here may be applied to large-scale systems with diameters of 100-150 m or more.

24369 Nuclear power systems. (to Babcock and Wilcox Co.). Netherlands Patent 7,600,474/A/. 19 Jan 1976. 10p. (In Dutch).

Priority 31 Mar 1975, USA; 1 fig.

A typical embodiment of the invention provides a compact nuclear power system in which a pressurized water reactor core coolant transfers its heat to a secondary coolant through one or more steam generator modules that are supported within the reactor pressure vessel. The reactor core coolant, however, flows through the tubes within the steam generator, while steam is raised from the secondary coolant on the shell side of the module. The simplified internal piping that this arrangement provides permits significant cost savings in reactor construction with increased safety and reliability.

24370 Nuclear reactor. Aleite, W.; Bock, H.W.; Struensee, S. (to Kraftwerk Union A.G.). German(FRG) Patent 2,432,347/A/. 22 Jan 1976. 9p. (In German).

3 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention concerns the use of burnable poisons in a nuclear reactor, especially in PWRs, in order to improve the controllability of the reactor. An unsymmetrical arrangement in the lattice is provided, if necessary also by insertion of special rods for these additions. It is proposed to arrange the burnable poisons in fuel elements taken over from a previous burn-up cycle and to distribute them, going out from the side facing the control rods, over not more than 20% of the lenth of the fuel elements. It seems sufficient, for the burnable poisons to bind an initial reactivity of only 0.1% and to become ineffective after normal operation of 3 to 4 months.

24371 Method and equipment for the thermal degassing of the primary coolant of nuclear reactors. Graemer, G.; Korn, R. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 2,104,356/B/. 12 Feb 1976. 3p. (In German).

3 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention relates to a method for the thermal degassing of the primary coolant of a nuclear reactor provided with pressure regulators using existing installations whenever possible. For this purpose,especially the pressure regulator and the pressure reduction tank are used so that only one gas scrubber column with gas adsorption device connected to it are installed additionally. It is also possible to install a device of this kind in existing PWR reactors.

24372 Neutron detector with monitoring elements. Haller, P. (to Kraftwerk Union A.G.). German(FRG) Patent 2,439,954/A/. 4 Mar 1976. 13p. (In German).

4 figs. Available from Dt. Patentamt, Muenchen (FRG).

To check the reliable reading of a neutron detector the signal of which results from (n,e) processes and which is used for neutron flux supervision in the reactor core of pressurized-water reactors, a circuit is given which makes it possible to record the isolation resistivity of the cable connected to the input of the current amplifier and of the neutron detector, this resistivity determining, among others, the output signal. For supervision, the input offset voltage of the current amplifier is modulated by a low-frequency ac voltage and a filter is assigned to the output of an op amplifier, this filter feeding a limiting value recorder.

24373 Nuclear reactor. Michel, E. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 2,261,477/C/. 25 Mar 1976. 4p. (In German).

2 figs. Available from Dt. Patentamt, Muenchen (FRG).

A PWR plant is described in which the steam generator as well as the primary-coolant pump arranged within the primary coolant tubes are placed outside the reactor pressure vessel and a safety sleeve surrounds the reactor pressure vessel, steam generator, primary coolant tubes, and primary coolant pump.

24374 Method of reactor fueling and fuel element. Weber, R. (to Kraftwerk Union A.G.). German(FRG) Patent 2,445,984/A/. 1 Apr 1976. 9p. (In German).

5 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention relates to a method of reactor fueling with a safe reactor building, particularly of pressurized-water reactors, with interchangeable cauless fuel elements consisting of a number of fuel elements and a composite fuel element frame to take up the fuel elements.

24375 **Steam generator.** Mayer, H.; Schroeder, H.J. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 2,231,236/C/. 20 May 1976. 4p. (In German).

2 figs. Available from Dt. Patentamt, Muenchen (FRG).

By the arrangement of a pre-heating chamber on the cold side of the U-tube bundle of a pressurired-water steam generator, the thermal economy is to be improved and in the flow rate increased by better steam-bubble condensation.

24376 **Method and circuit to remove the after-heat of a PWR reactor in accidents.** Bohm, D.; Gess, G.; Caspar, P.; Kley, H. (to Babcock - Brown Boveri Reaktor G.m.b.H.). German(FRG) Patent 2,459,150/A/. 16 Jun 1976. 11p. (In German).

3 figs. Available from Dt. Patentamt, Muenchen (FRG).

The device condenses the vapour caused by the after-heat via the extended intermediate cooling circuit and leads it back to the vapour producer. The circuit principles necessary are shown.

24377 **Main-steam isolation system for PWR reactors.** Hoffmann, J. (to Kraftwerk Union A.G.). German(FRG) Patent 2,403,668/C/. 1 Jul 1976. 4p. (In German).

3 figs.

An isolation device is disclosed for the steam pipe of a steam generator, leading out of the containment where the steam generator is located. The device has an isolation valve, a safety valve and/or a letdown valve, with a double-walled steam line duct leading through the containment.

24378 **Safety systems of KWU pressurised water reactors.** Bachmann, G.; Geyer, K.; Helf, H.; Hellmerichs, K. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). *Kerntechnik;* **18**: No. 8;9, 374-381(Aug 1976). (In German; English).

9 figs.

The paper discribes the concept of the reactor system of the KWU pressurised water reactor. A review of the accidents to be taken into account, including accidents caused by external events, and of the countermeasures which must be initiated, is followed by a description of the design and loyout of the reactor protection system.

24379 **Biblis A nuclear power station: commissioning and first operating experience.** Meyer, F. (Rheinisch-Westfaelisches Elektrizitaetswerk A.G., Biblis (Germany, F.R.). Betriebsverwaltung). *Atomwirtsch., Atomtech.;* **21**: No. 9;10, 479-485(Sep 1976). (In German).

From Reactor meeting; Duesseldorf, Germany, F.R. (30 Mar 1976).

4 figs.; 4 tabs.; 11 refs.

The Biblis A Nuclear Power Station, one of the world's largest nuclear power plants, has fulfilled all expectations in its commissioning phase and the subsequent power operation extending over more then eighteen months and has proved that it is possible to operate generating units of this size safely. The nuclear power station, which is equipped with a pressurized water reactor and a single shaft turbogenerator set and has an electric power of 1,200 MW, had been started up in the summer of 1974, after a construction period of four years, and accepted by RWE on schedule in February 1975. The outages which have occurred since the acceptance date, which are covered in detail in the report, were caused primarily by the conventional part of the plant. Cases of this type include defects and maloperation of the mechanical cooling water clean-up system, the instrument transformers of the generator, the high pressure casing of the turbine, and the secondary feed water tank. In the nuclear part of the plant the outages were due mainly to defects of the hydrodynamic shaft seals of the main coolant pumps. All defects were safely controlled by the control and regulating systems of the plant. The behavior of the fuel elements has been normal so far. The radioactivity levels released into the environment were far below the limits prescribed by the licensing authorities.

24380 **Higher value in litigation for nuclear power plant proceedings.** *Energiewirtsch. Tagesfragen;* **26**: No. 10, 625(Oct 1976). (In German).

The administrative court of Bavaria has rejected in its ruling of 19th August 1976 - No. 117 VI 76 - an appeal against the fixing of the value in litigation according to the judgment of the administrative court in Wuerzburg of 10th March 1976, and it has confirmed DM 20,000 as the disputed sum. The essential points of the grounds upon which the rejection is based are presented.

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

REFER ALSO TO CITATION(S) 24061, 24345, 24506, 24682, 24694, 24748

24381 (GA-A—12897) **Irradiation experience with HTGR fuels in the Peach Bottom Reactor.** Scheffel, W.J.; Scott, C.B. (General Atomic Co., San Diego, Calif. (USA)). 1 Nov 1974. Contract E(04-3)-0167-PRJ-17. 47p. (CONF-740608—16). Dep. NTIS $4.00.

From Annual meeting of the American Nuclear Society; Philadelphia, Pennsylvania, USA (23 Jun 1974).

Fuel performance in the Peach Bottom High-Temperature Gas-Cooled Reactor (HTGR) is reviewed, including (1) the driver elements in the second core and (2) the test elements designed to test fuel for larger HTGR plants. Core 2 of this reactor, which is operated by the Philadelphia Electric Company, performed reliably with an average nuclear steam supply availability of 85 percent since its startup in July 1970. Core 2 had accumulated a total of 897.5 equivalent full power days (EFPD), almost exactly its design lifetime of 900 EFPD, when the plant was shut down permanently on October 31, 1974. Gaseous fission product release and the activity of the main circulating loop remained significantly below the limits allowed by the technical specifications and the levels observed during operation of Core 1. The low circulating activity and postirradiation examination of driver fuel elements have demonstrated the improved irradiation stability of the coated fuel particles in Core 2. Irradiation data obtained from these tests substantiate the performance predictions based on accelerated tests and complement the fuel design effort by providing irradiation data in the low neutron fluence region.

24382 (GA-A—13038) **Fort St. Vrain initial fuel loading and physics tests.** Asmussen, K.E.; Brown, J.R.; Nirschl, R.J.; Pfeiffer, W.W.; Simon, W.A. (General Atomic Co., San Diego, Calif. (USA)). Sep 1974. Contract E(04-3)-0633. 44p. Dep. NTIS $4.00.

The full-power operating license for the Fort St. Vrain Nuclear Generation Station was issued by the AEC on December 21, 1973. Core loading was started on December 27, 1973, and the loading of the 2274 fuel and reflector elements was completed in 20 days. Initial criticality was achieved on January 31, 1974. The critical control rod position indicated an 0.003 Δk difference between the predicted and actual critical core configuration. Pulsed-neutron measurements were performed to obtain the shutdown margin with all control rods inserted, the shutdown margin with the highest worth control rod pairs removed, and the reactivity worth of the control rod groups removed in the normal sequence in the approach to critical. Following the initial criticality, measurements of the axial flux distribution were performed in several regions of the core. The cold zero power measurements were performed with air in the core so that personnel access to the core cavity was possible to permit placement of in-core instrumentation. After completion of the cold physics measurements, the special in-core instrumentation was removed and the primary system was sealed and filled with helium. Measurements of reactivity coefficients are scheduled to be performed as part of the hot physics testing. Additional physics tests are scheduled for the rise-to-power test program and include measurements of control rod worth, temperature coefficient, xenon reactivity, and xenon stability.

24383 (GA-A—13827) **Postirradiation examination of capsules P13R and P13S.** Scott, C.B.; Harmon, D.P.; Holzgraf, J.F. (General Atomic Co., San Diego, Calif. (USA)). 8 Oct 1976. Contract E(04-3)-0167-PRJ-17. vp. Dep. NTIS $11.00.

Capsules P13R and P13S were the seventh and eighth in a series of irradiation tests conducted under the ERDA-sponsored HTGR Fuels and Core Development Program. Reference type LHTGR fuel fabricated with a broad spectrum of property and process variables was irradiated to extreme temperature and fluence conditions. Postirradiation examination revealed that the bonded fuel rods exhibited good stability after irradiation to fast neutron fluences of 12.4×10^{21} n/cm^2 (E greater than 0.18 MeV), which is 55 percent beyond the LHTGR peak design fast neutron fluence of 8.0×10^{21} n/cm^2. Thermal cycling to high temperatures did not adversely affect fuel rod integrity. Particle batches with coating designs representative of the design requirements envisioned for the LHTGR exhibited excellent irradiation performance. Ten batches of fissile and fertile particles were irradiated without coating failure to fast neutron exposures which exceeded the LHTGR peak design exposure by 35 to 52 percent. Capsules P13R and P13S were considered to be very successful qualification tests of LHTGR fuel components. These results provided a substantial data base for the LHTGR Fuel Product Specification and Performance Models used in HTGR core design studies, and demonstrated the excellent irradiation performance of reference LHTGR fuel to well beyond peak design exposures.

24384 (GA-A—14097) **Gas Turbine HTGR program. Quarterly progress and task closeout report for the period ending September 30,**

1976. (General Atomic Co., San Diego, Calif. (USA)). Oct 1976. Contract E(04-3)-0167-PRJ-46. vp. Dep. NTIS $7.75.

The report includes a status summary of the research and development of the power plant. The status summary will serve as a close-out report for those tasks which will not be continued because of reduced scope and funding in FY-1977. The report describes the basis for the performance estimates at 850°C and 950°C core outlet temperatures. Overall plant efficiency of over 50 percent is shown for the latter case as a binary-cycle plant. The report describes component design requirements for the elevated temperature case and the conceptual designs at various ammonia bottoming-cycle components. A review of plant safety is presented, including that for the binary-cycle plant. Mechanically and aerodynamically improved designs for the turbomachines are described based upon test data from the FT-50 engine, from use of a welded turbine rotor, from mounting two compressor stages per disk, and from alternate material selection. Studies of a core having an outlet temperature of 950°C and favorable conversion ratio and neutronics are described. Control studies, fission product plateout studies, and material testing in helium are summarized. Balance-of-plant layouts and requirements are described. Advances in PCRV and internals are discussed. The status of heat exchangers and control valves is reviewed.

24385 (GA-A—14161) **Gamma scanning the primary circuit of the Peach Bottom HTGR.** Hanson, D.L.; Baldwin, N.L.; Selph, W.E. (General Atomic Co., San Diego, Calif. (USA)). 31 Oct 1976. Contract E(04-3)-0167-PRJ-56. 72p. (CONF-761103—18). Dep. NTIS $4.50.

From ANS winter meeting; Washington, District of Columbia, United States of America (USA) (15 Nov 1976).

The plateout distribution of gamma-emitting nuclides in the primary circuit of the Peach Bottom HTGR at end-of-life has been determined by in situ gamma scanning. The specific activity was mapped by scanning the accessible ducting at 12 locations with a Ge(Li) detector and by axially traversing 79 steam generator tubes with travelling CdTe detectors from the water side. Following destructive removal of trepan samples, a travelling intrinsic germanium detector was inserted sequentially into two vertical ducts and the plateout mapped along 6-m runs of ducting. Calibration measurements on mockups allowed reduction of the spectra to specific activity. The measured plateout profiles were in excellent agreement with those predicted with the PAD code. The dominant gamma emitters were Cs-137 and Cs-134; their relative distributions were similar. Little local structure to the plateout in the ducts was observed, only a gradual decrease in specific activity in the direction of coolant flow. In the steam generator, a significant entrance effect was observed in the superheater section; the activity was highest where the inlet jet impinged and lowest at the ends of the bundle despite the presence of a flow baffle. The effect damped out with penetration into the bundle, and the axial profile was uniform at the economizer exit. When the axial profiles are averaged, the specific activity decreased monotonically across the tube bundle. Cesium deposition throughout the circuit was apparently mass transfer controlled with the exception of the hot duct where the accumulation was limited by the high temperatures. The superheater entrance effect probably resulted from the maldistribution of coolant flow. The profiles suggest that cesium was transported primarily in atomic form despite the presence of carbonaceous dust. Finally, the measured plateout distribution verifies the reference methodology used to make such predictions for large HTGR design.

24386 **System for the cooling of structure materials of a rector core and for the after-heat removal.** Foerster, S.; Schneider, K.U.; Haarmann, K.W. (to Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). German(FRG) Patent 2,160,507/B/. 19 Sep 1974. 5p. (In German).

2 figs.

Cooling of the structural elements of the reactor and removal of the decay heat is carried out. This is also achieved independently of perturbations in the primary circuit. For this purpose, a thermal shield is arranged in the annular space between reflector and reactor pressure vessel of prestressed concrete. The thermal shield is connected with a cooling system consisting of a radiator. Heat transfer may take place by conduction or convection if the free space of the annulus is filled by solid material or cooling gas. In the latter case the gas is flowing undisturbedly through the radiator. Its upper outlet is connected with the suction side of circulating blowers. On failure of these blowers, the decay heat is removed by natural circulation which is achieved by certain positions of valves, e.g. at the gas inlet and outlet or behind the circulating blowers, looking in flow direction, and in the annular space. The lower outlet on the radiator is connected with the coolant flow from the core by means fo thermal reverse blocking.

24387 **Shear strength of end slabs of prestressed concrete reactor vessels.** Cheung, K.C.; Gotschall, H.L.; Liu, T.C. (General Atomic Co., San Diego, Calif. (USA)). pp 9p, Paper H4/9 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Prestressed concrete reactor vessels (PCRV's) have been adopted for primary containments in most large high-temperature gas-cooled reactor installations. The most common configuration for PCRVs is a right-vertical cylinder with thick end slabs. In order to assess the integrity of a PCRV it is necessary to predict the ultimate strength of the end slabs. The complexity of the basic mechanism of shear failure in the PCRV end slabs has thus far prohibited the development of a completely analytical solution. However, many experimental investigations of PCRV end slabs have been conducted over the past decade. This information makes it possible to establish empirical formulae for the ultimate strength of PCRV end slabs. The basis and development of an empirical shear-flexure interaction expression is presented.

24388 **Analysis of prestressed concrete reactor vessels under high thermal gradient.** Guelkan, P.; Akay, H.U. (Middle East Technical Univ., Ankara (Turkey)). pp 8p, Paper H2/4 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Gas cooled nuclear reactors often require a large core space for which prestressed concrete reactor vessels have been adopted. These vessels are currently being designed as radially and transversely prestressed cylinders capped with flat end slabs or hemispherical heads, or as spherical shells. A finite element solution is presented for cylindrical vessels with flat end slabs. The effect of introducing cracks of arbitrary orientation at the cylinder slab junction is investigated. Although the analysis is made for linearly elastic materials, it is shown that cracking at the reentrant corner effects the distribution of radial displacement on the inside face of the end slab, and increases tensile strains on the outside face of the end slab. The effect of temperature variation through the thickness is investigated for a given state of initial stresses. It is concluded that thick axisymmetric shell elements can be employed with good accuracy in the structural analysis of vessels of the type considered.

24389 **Method of sliced sub-structure in the analysis of boiler podded PCPV.** Kawamata, S. (Tokyo Univ. (Japan). Inst. of Industrial Science); Isobata, O. (Shimizu Construction Co. Ltd., Tokyo (Japan). Research Lab.); Kuroda, T. (Electric Power Development Co. Ltd., Tokyo (Japan)). pp 10p, Paper H2/6 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The method of sliced substructures, a new method of simplified three-dimensional analysis of the boiler podded PCPV is proposed and the efficiency and the accuracy obtainable by this method are shown by examples of actual analysis of a boiler-podded PCPV for HTGR.

24390 **Vibration studies of the new primary circuit of the CHINON 3 reactor.** Baylac, G. (Electricite de France, 78 - Chatou. Direction des Etudes et Recherches); Copin, A. (Electricite de France, 78 - Chatou). pp 4/3 1-9 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

During 1974 a new primary circuit has been manufactured for the CHINON 3 gas-cooled reactor. The vibrations of this circuit were analysed with computer programs using experimental data concerning the sources of vibration. The considered sources of vibrations were: the mechanical vibrations (6μm R.M.S.) and the noise (150dB) of the blower, the noise in the heat exchanger (160dB) and the turbulence induced in the mitre elbows. After having studied the amplification of the noise in the circuit, the behaviour of the system of pipes was analysed, then the behaviour of special elements such as the expansion joints and guide vanes situated in the elbows. It appeared that the computed stresses were weak (less than 1 hbar R.M.S.) except for the stresses in the cascades. Thus a program of measurements was undertaken in laboratory, using a 0.2 scale mock-up.

24391 **Computation of deformation and stresses in graphite blocks for HTR core survey purposes.** Besdo, D. (Technische Univ. Braunschweig (Germany, F.R.)); Theymann, W. (Hochtemperatur-Reaktorbau G.m.b.H., Mannheim (Germany, F.R.)). pp C1/8 1-6 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Stresses and deformations in graphite fuel elements for HTRs are caused by the temperature distribution and by irradiation under influence of creep, shrinking, thermal strains, and elastic deformations. The material behaviour can be treated as linear in the follow-

ing sense. If the irradiation is given i.e. the shrinking deformations are known, solutions which consider stresses and deformations resulting from thermal effects only, can be superimposed to any complete solution. Hence, it is allowed to distinguish between the stress field induced by the global distribution of a mean temperature and by irradiation, which can be considered as distributed smoothly, on the one hand and the stresses caused by local variations of the temperature on the other hand. Here, only the first effect is considered. The global deformations and the stress distributions in a prismatic fuel-element containing regularly distributed axial holes for the coolant flow and the fuel sticks can be computed in the following manner. The block with its holes is treated as an effective homogeneous continuum with an equivalent global behaviour. Assuming that the fourth-order-tensor of the elastic constants is proportional to the corresponding tensor in the constitutive equations for creep, only the effective strains are of interest. The values of temperature and dose may be given in n points of the block at certain points of time. Then, the inelastic nonthermal strains are integrated by a Runge-Kutta-procedure in the n points. When interpolated and combined with thermal strains, they are incompatible. Hence they produce elastic deformations which cause creep and can be computed by use of a Ritz-polynomial series.

24392 Significance of strength of siliconcarbide for the mechanical integrity of coated fuel particles for HTRs. Bongartz, K.; Scheer, A.; Schuster, H.; Taeuber, K. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). pp C1/2 1-9 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Silicon carbide (SiC) and pyrocarbon are used as coating material for the HTR fuel particles. The PyC shell having a certain strength acts as a pressure vessel for the fission gases whereas the SiC shell has to retain the solid fission products in the fuel kernel. For measuring the strength of coating materials the so-called Brittle Ring Test was developed. The values measured for the strength of the SiC were high (400-700 MN/m^2), it could therefore be assumed that a SiC layer might contribute significantly also to the mechanical strength of the fuel coating. The result indicates that, in optimising the coating of a fuel particle, the PyC layers of a multilayer coating should be considered alone as protective layers for the SiC. The SiC shell, besides acting as a fission product barrier, is then also responsible for the mechanical integrity of the particle.

24393 Experimental and analytical results for a prestressed concrete reactor vessel model under simulated HTGR operating conditions. Callahan, J.P.; Corum, J.M.; Whitman, G.D. (Oak Ridge National Lab., Tenn. (USA)). pp H3/2 1-9 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The thermal cylinder experiment was designed both to provide information for evaluating the capability of analytical methods to predict time-dependent stress-strain behaviour of a 1/6-scale single cavity prestressed concrete reactor vessel model and to demonstrate structural behaviour under design and off-design thermal conditions. The model was a thick walled cylinder having a height of 1.22 m, a thickness of 0.3 m and an outer diameter of 2.06 m. It was prestressed both axially and circumferentially and subjected to 4.83 MNm^{-2} internal pressure together with a thermal crossfall imposed by heating the inner surface of the cylinder to 65.6°C and cooling the outer surfaces to 23.9°C. Since the test was designed to study the behaviour of the barrel section of a massive concrete structure, all exposed surfaces were sealed to prevent heat flow in the axial direction. The initial 460 days of testing were divided into time periods that simulated prestressing heat-up, reactor operation and refueling. At the conclusion of the simulated refueling period, the model was repressurized, and a narrow circumferential band at the inner surface was heated to 232.2°C for 84 days to produce an off-design hot-spot condition. Comparison of experimental strain gage data with time-dependent analysis predictions obtained using the SAFE-CRACK finite element computer program indicated generally good agreement for the normal vessel operating period, although the analysis tended to underestimate heating strains and overestimate mechanical loading strains.

24394 Development of prestressed concrete pressure vessel for H.T.R. Garas, F.K. (Taylor Woodrow Construction Ltd., Southall (UK)). pp H3/1 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24395 Rotational plane strain and its application in two-dimensional finite element analysis. Kinkead, A.N. (Organization for Economic Co-Operation and Development, Winfrith (UK). High Temperature Reactor Project). pp C1/9 1-13 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

A boundary restraint condition of practical importance to prismatic gas cooled reactor core construction has been identified, defined as Rotational Plane Strain and incorporated in a two-dimensional finite element/dose dependent stress code for transversely isotropic graphite structures as an option to the customary Engineering (or Generalised) Plane Strain state. The main application envisaged is in problems whose size or complexity precludes the application of three-dimensional analysis.

24396 Theoretical and experimental studies on bellows type expansion joints behaviour of CHINON 3 primary coolant system. Vrillon, B.; Jeanpierre, F. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service des Etudes Mecaniques et Thermiques); Copin, A. (Electricite de France, 75 - Paris. Direction de la Production et du Transport); Gregoire, J.P. (Electricite de France, 75 - Paris. Direction des Etudes et Recherches). pp F6/6 1-9 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

In rebuilding the primary coolant circuit of the Chinon 3 reactor it was necessary to qualify certain components, including the bellows type expansion joints. These joints, of diameter 1800 millimeters, are designed to support a working pressure of 30 bars for a maximum temperature of 410°C. They are hydraulically formed with a double stainless steel membrane. With regard to mechanical resistance, calculations by finite elements in the elastic field having shown the yield stress of metal used for the waves to be widely overstepped for the specified working values, calculations were undertaken in the elastoplastic field with metal strain hardening during the cyclic pressure and angular deformation undergone by the bellows joints on the reactor. The results of these calculations, carried out with the PASTEL programme in kinematic strain hardening, were interpreted with a view to estimating the resistance of the joints under fatigue conditions. Failure fatigue tests on three bellows joints, identical with those equipping the reactor showed that the lifetimes estimated from calculations allied with the breaking cycle number values obtained experimentally. A vibration study of the bellows was performed. The results obtained from the tests show that the use of bellows type expansion joints on a primary reactor circuit offers the same guarantees of reliability and resistance as any other circuit component under pressure, as long as the strains they undergo remain within the limits specified by the regulations and nuclear codifications.

24397 (ORNL-tr—4250) Primary test for brick rupture with recording of sound emission. Bernard, P.; Bonarel, R.; Bogdanovitch, M.; Tortel, J. 15 Jan 1975. Translation by M. Gerrard from French. 15p. Dep. NTIS $3.50.

It is shown that the detection of isthmus rupture by acoustic emission is possible for graphite bricks. Judicious choice of detectors facilitates characterization of the material. The use of several captors does not pose problems and is considered necessary to compensate the attenuation caused by the holes.

24398 Nuclear power station with closed gas cooling cycle. Haferkamp, D.; Hodzic, A.; Winter, U. (to Hochtemperatur-Reaktorbau G.m.b.H.). German(FRG) Patent 2,404,843/A/. 14 Aug 1975. 25p. (In German).

4 figs.

The HTR, a graphite-moderated, helium-cooled pebble bed reactor has a closed gas cooling circuit with gas turbogenerator set, heat exchangers with pre- and intermediate coolers, as well as gas inlet pipes built in integrated design. The gas turbogenerator is placed in a tunnel below the reactor which is arranged in the center of a cavern. For incorporating the recuperators and coolers, vertical pits ('pods') are provided on a circle around the cavern. The precoolers are arranged vertically above or below the recuperators. The gas pipes between the single components are built straight-lined and horizontally or vertically. The vertical pipes are designed as pods. For carrying high-pressure gas several pods with horizontal joints are provided, while carrying of low-pressure gas is achieved by a horizontal piping system below the turbo-tunnel. Because of this integrated symmetrical design, all the components are easily accessible for maintenance and repair.

24399 Research and development of the prestressed concrete reactor vessel. Shiozawa, S.; Omata, I.; Nakamura, N. (Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan)). *Ishikawajima-Harima Giho;* **15**: No. 6, 711-717(Nov 1975). (In Japanese).

A study of the PCRV liner cooling system has been completed. In this study applying a large cylindrical PCRV model, comparison was made between experimental data and analyses concerning

the liner cooling system, and the results of the analytical technique have been evaluated. The analytical technique established is applicable to the estimation of temprature distribution in the concrete of a large PCRV and also to the evaluation of the liner cooling system.

24400 Heat exchanger with circular or hexagonal cross section. Ecker, H. (to Hochtemperatur-Reaktorbau G.m.b.H.). German(FRG) Patent 2,430,161/A/. 15 Jan 1976. 17p. (In German).

3 figs. Available from Dt. Patentamt, Muenchen (FRG).

Heat exchangers to be used for closed gas turbine plants or in nuclear power plant engineering should have a total volume as small as possible. A heat exchanger is described which has a number of straight tubes united to tube bundles which, within an outer guide jacket, lie parallel to the central axis. The boxes formed by the tube bundles with the accompanying tube sheets and the inner guide jacket and arranged in a hexagonal lattice show displacements of the tube sheets against each other in at least three different planes perpendicular to the central axis, leaving only little free space. Two heat exchangers built according to the invention are described as design examples they can be used as a recuperator of a high temperature reactor coupled with a helium turbine.

24401 Heat exchanger for installation in a nuclear reactor. Marsch, H.D. (to Uhde (F.) G.m.b.H.). German(FRG) Patent 2,431,478/A/. 22 Jan 1976. 9p. (In German).

1 fig. Available from Dt. Patentamt, Muenchen (FRG).

A heat exchanger is described which is to make use of the waste heat of a high-temperature nuclear reactor for performing chemical processes. The heat exchanger is arranged within a double-walled vessel within a steel-coated cavern of the prestressed-concrete vessel wall. The reaction tubes filled with a catalyst are heated by hot circuit gas of the reactor installation. The invention relates to the constructional design of an installation of that kind taking into consideration that installing and service are uncomplicated, but meet stringent safety requirements. The heat exchanger reposes on a ring console in the lower part of the steel coating, the supply and discharge tubes are guided through the closure head and can be blocked individually or section-wise. The ring space is double-tightened.

24402 Method to produce prismatic fuel element blocks for high-temperature reactors. Huschka, H.; Herrmann, F.J. (to Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM)). German(FRG) Patent 2,208,855/B/. 19 Feb 1976. 4p. (In German).

2 figs. Available from Dt. Patentamt, Muenchen (FRG).

Prismatic fuel element blocks for high-temperature reactors with cylindrical bores for accepting the nuclear fuel charges (consisting of coated fuel particles and graphite matrix) often have a gap retarding the heat transfer between the graphite block and the introduced fuel charge. According to the invention, this can be prevented by performing the heat treatment of the pressed fuel charge only when it has already been introduced into the bore of the graphite block; the graphite pressing powder should consist of natural graphite with up to 15% binder shares, if desired.

24403 Hot box system for gases with high temperature and pressure. Hodzic, A.; Haferkamp, D.; Stach, H.; Paetz, E. (to Hochtemperatur-Reaktorbau G.m.b.H.). German(FRG) Patent 2,439,224/A/. 26 Feb 1976. 21p. (In German).

4 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention relates to the design of the gas flow system in a gas-cooled high-temperature reactor, which is provided for gases of high temperatures and high pressures. To guide the gases within the pressurized vessel enclosing the reactor core, internally insulated pipelines are provided each of which has with a pressure jacket, they are cooled by means of a cold gas flow. They may be laid separately or be guided as ducts within the wall of the prestressed-concrete pressurized vessel. In detail, the advantageous anchoring elements, compensating elements for balancing heat expansion and the design of the disconnectable connections are described. The system meets all safety requirements and provides for repair and replacement of parts of the system.

24404 Method of production of spherical coated nuclear fuel particles. Vygen, P.; Diettler, A.; Micheel, G. (to Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM)). German(FRG) Patent 2,102,438/B/. 26 Feb 1976. 7p. (In German).

7 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention concerns the improvement of the construction of the nozzle part of a fluidized-bed furnace which is to make the interspace volume and the coating gas concentration in it constant in time and space during the whole coating process. The mixture of inert and coating gas is introduced into the conical bottom of the fluidized bed through several nozzles concentrically enclosed by bores or annular gaps.

24405 Method of producing block fuel elements for high temperature power reactors. Hrovat, M.; Wolff, W.; Hackstein, K.G. (to Nuklear-Chemie and -Metallurgie G.m.b.H. (NUKEM)). German(FRG) Patent 2,207,011/B/. 16 Jun 1976. 1p. (In German).

Available from Dt. Patentamt, Muenchen (FRG).

Pressed block fuel elements for gas-cooled high temperature reactors are produced by hot pressing of granulate (of graphite powder and binder) with coated and cladded fuel particles at low pressure. The patent claim deals with the fact that the cooling channels of the block element are directly pressed without any mechanical processing.

24406 Improvements in or relating to nuclear reactors. George, B.V.; Cook, R.K. (to Nuclear Power Co. (Whetstone) Ltd. (UK)). British Patent 1,445,719/B/. 11 Aug 1976. 5p.p.

Reference is made to gas cooled reactors in which the gaseous coolant is used directly as the working fluid for closed cycle gas turbines. In the system described in addition to the main circulatory system that incorporates the main gas turbines an auxiliary circulatory system is provided around which a small proportion of the coolant is arranged to flow after passage through the reactor core and in which a steam generating boiler is located, the steam being utilised to drive a steam turbine for an auxiliary electric generator. Such an arrangement enables the reactor to be started up utilising the auxiliary circulatory system independently of the main gas turbine start-up procedure. This is an advantage since the large power required to drive the compressors of gas turbine plant give rise to starting problems, and special provision has to be made to ensure that the turbine rotor attains a speed sufficient to allow the turbine drive to be self-sustaining. In addition long term heat removal, either after a reactor trip or under normal reactor shut-down conditions, can be considerably simplified by shutting down the gas turbine and removing heat by the auxiliary circulatory system. The steam turbine associated with the steam generating boiler is preferably arranged to run continuously during operation of the reactor. A number of gas turbine units can be disposed around the reactorcore in chambers in the pressure vessel wall or in the space between the main pressure vessel and a secondary pressure vessel.

24407 Homogenization of the flow of spheres in pebble bed reactors. Heil, J.; Lohnert, G.; Mueller-Frank, U. (to Internationale Atomreaktorbau G.m.b.H. (INTERATOM)). German(FRG) Patent 2,456,405/A/. 12 Aug 1976. 11p. (In German).

3 figs. Available from Dt. Patentamt, Muenchen (FRG).

The claim relates to a device consisting of a conical body with guide ducts at the lower side arranged in a funnel-shaped mouth at the core bottom. Subject of the claim is the arrangement of the guide ducts converging towards the middle into a single duct.

24408 Inhibition of moderator graphite corrosion in CEGB Magnox reactors. Part 1. Laboratory measurements of the effect of coolant composition on the radiolytic graphite/CO_2 reaction. Best, J.V.; Wickham, A.J.; Wood, C.J. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). *J. Br. Nucl. Energy Soc.;* **15**: No. 4, 319-324(Oct 1976).

An experimental programme on the inhibition of Magnox reactor moderator graphite corrosion is described. The effect of hydrogen, methane and water on the rate of the radiation-induced reaction between graphite and CO_2 has been determined in a gamma irradiation facility. Methane is less effective at the lower temperature of Magnox reactor cores, as compared to advanced gas cooled reactor temperatures, whereas water is more efficient at Magnox reactor temperatures. The mechanisms of inhibition are discussed, and it is concluded that addition of hydrogen to the reactor coolant is the preferred method of controlling moderator corrosion.

24409 Inhibition of moderator graphite corrosion in CEGB Magnox reactors. Part 2. Hydrogen injections into Wylfa reactor 1 coolant gas. Best, J.V.; Wickham, A.J.; Wood, C.J. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). *J. Br. Nucl. Energy Soc.;* **15**: No. 4, 325-331(Oct 1976).

The requirement for inhibition of moderator corrosion in CEGB Magnox reactors is considered, and experimental injections of hydrogen into an operating reactor at Wylfa are described. The coolant chemistry of the reactor is discussed with respect to the kinetics of methane and water formation. The reduction in the rate of graphite corrosion following hydrogen injection is shown to agree well with the laboratory data and with operational data from other reactors. The reactor information, together with the laboratory data, will allow the optimum hydrogen concentration to be defined for further operation of the Board's reactors.

24410 High pressure fuel test loops in Windscale AGR - design, installation and commissioning experience. Chapman, D.A. (UKAEA Reactor Group, Risley). *J. Br. Nucl. Energy Soc.;* **15**: No. 4, 333-340(Oct 1976).

Novel design features of, and some of the problems overcome in the installation and commissioning of, two new self-contained high pressure (850 psia) loops in Windscale AGR are described. Their function is to facilitate the testing of commercial AGR fuel pins under conditions of temperature, pressure, coolant composition, and power cycling which simulate power station operating requirements.

24411 Research on a 2700-MW(th) pebble-bed reactor for a helium-turbine power plant. Ruetten, H.J.; Teuchert, E. (Kernforschungsanlage, Juelich, Ger.). *Nucl. Technol.;* **31**: No. 2, 164-171(Nov 1976).

A favorable distribution of the fuel temperature in combination with a high cooling gas outlet temperature as necessary for a helium-turbine power plant can be achieved in a pebble-bed reactor with "once-through-then-out" fueling without leaving the scope of present feasibility. The equilibrium cycle is reached after a well-balanced and short running-in period. For non-base-load operation, the reactor can be controlled by moving the control rods in the upper void above the pebble bed. Withdrawing the rods causes an increase of the maximum fuel temperature by only 56°C. To avoid replacing of the side reflector during a time of 30 yr, the fast-neutron flux in the reflector can be markedly lowered by inserting a certain amount of neutron poison into the reflector graphite and by an outer ring of "breeding" fuel elements, respectively.

24412 Crushing strength of high-temperature gas-cooled reactor fuel particles. Lackey, W.J.; Stinton, D.P.; Davis, L.E.; Beatty, R.L. (Oak Ridge National Lab., TN). *Nucl. Technol.;* **31**: No. 2, 191-201(Nov 1976).

The whole-particle crushing strengths of high-temperature gas-cooled reactor fertile and fissile coated particles were measured and correlated with fabrication procedures. The crushing strength of Biso-coated fertile particles was increased by the following factors: (1) Increasing the outer coating thickness by 10 μm increased strengths by 0.3 lb (1.3 N) for annealed particles and by 0.5 lb (2.2 N) for unannealed particles. (2) An 1800°C postcoating anneal increased strengths by 1 lb (4.4 N) for particles with thick outer coatings and by 2 lb (8.9 N) for particles having thin coatings. (3) Increasing the inner coating density by 0.1 g/cm^3 increased strength by 0.6 lb (2.7 N). The crushing strength of Triso-coated fissile particles was proportional to the thickness of the SiC coatings, and strength decreased on annealing by approximately 0.2 lb (0.9 N) when a porous plate was used to distribute the coating gas and by approximately 1.5 lb (6.7 N) when a conical gas distributor was used. The strengths of fertile and fissile coated particles as well as uncoated kernels appear adequate to allow fuel fabrication without excessive particle damage.

POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED

REFER ALSO TO CITATION(S) 24779, 24780, 24787

24413 Experimental development of design criterion to limit liquid flow induced vibration in nuclear reactor steam generators. Gorman, D.J.; Mirza, S. (Ottawa Univ., Ontario (Canada)). pp 8p, Paper F7/6 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The need for design criterion to limit amplitudes of liquid cross flow induced vibration of tube bundles took on great significance with the development of the current generation of heavy water cooled and moderated Canadian Nuclear Power Reactors. Associated with the primary coolant circuits of the reactors are large inverted U-tube steam generators which transfer heat from the primary circuit, tube side, to the boiling light water, shell side. Vibration induced damage to the tubes, with ensuing mingling of heavy and light water is not acceptable. The research described is confined to the lower portion of the steam generators where liquid cross flow of the light water occurs. There exist two significant modes of tube excitation which can lead to large amplitude vibration. These are the Connors type excitation, sometimes known as Connors instability, which permeates the entire bundle, and the vortex shedding phenomenon found here to be significant only at the first and second rows of tubes leading into the bundle. This latter observation is of particular importance because, to the authors' knowledge, it has not been heretofore discussed in the technical literature. The possibility of adding mid-span support to the inlet tubes is discussed. The main parameters which have been studied in this work are tube diameters, pitch-to-diameter ratios, flow directions, and liquid velocities, etc. Both equilateral triangular and square pitch tube arrays have been studied.

24414 Pressure bursts due to power channel explosion in a pressure tube reactor. Famiglietti, M.; Parmeggiani, A.; Possa, G. (Centro Informazioni Studi Esperienze, Milan (Italy)); Galbiati, L. (Comitato Nazionale per l'Energia Nucleare, Ispra (Italy)). pp F8/2 1-12 of In Structural mechanis in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The paper presents the main results of the first part of an experimental program sponsored by CNEN under way at CCR Euratom (Ispra) in the framework of the studies for the safety assessment of the CIRENE reactor. The objective of this program is the determination of pressure field transient in the D_2O tank associated with a complete sudden pressure tube rupture. Owing to the presence in the pressure tube of water and of steam-water mixture at elevated pressure and temperature, this rupture is of explosive type and triggers in the D_2O tank a complex fluid-dynamic transient, characterized in the liquid volume by sharp pressure peaks well separated in time. About 30 explosion tests have been made. Typical explosion pressure transients are presented. Indications of the spatial distribution of the most relevant pressure peaks, namely the first and the second, are given. Detailed mechanisms for the pressure peaks' origins are proposed on the basis of available experimental data. Significant indications are given regarding the influence on pressure transients of various plant conditions, such as the nature of the fluid inside the pressure tube (approximately saturated liquid water or steam at various pressures and temperatures), the temperature of the water in the tank, and the cover gas volume.

24415 Dynamics and stability of flexible cylinders subjected to liquid and two-phase axial flow in confined annuli. Pettigrew, M.J. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.); Paidoussis, M.P. (McGill Univ., Montreal, Quebec (Canada). Dept. of Mechanical Engineering). pp D2/6 1-10 of In Structural mechanics reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The nuclear fuel for CANDU-BLW reactors consists of fuel bundles assembled in the form of strings. The strings are inserted in fuel channels. From a fluidelastic viewpoint the strings are essentially flexible cylinders in confined annuli. The flow conditions in a fuel channel are typically 400 g/cm^{2}s and 15% steam quality. Fluidelastic instability is one of the flow-induced vibration excitation mechanisms that could cause fretting damage. The fluidelastic behaviour of a flexible cylinder in axial flow has been studied before both experimentally and analytically. These studies were limited to an isolated cylinder in liquid flow. In the note presented, the analysis is extended to consider the effect of cylinder confinement in an annulus. The effects on virtual mass and fluid frictional forces are taken into account whereas the interaction between the cylinder and the annulus wall is not to keep the resulting mathematical model linear. The formulated model is qualitively valid for liquid flow but not for two-phase flow.

24416 Level indicator with vibrating needle contact. Krejci, M.; Stulik, P. Czech Patent 157,484. 15 Apr 1975. 3p. (In Czech).

A high-precision level indicator is proposed, mainly for heavy water level indication in a nuclear reactor. The sensor has increased resistance against corrosion of the needle contact placed inside the system of two electrodes having the shape of lidless vessels. The inner electrode is placed inside the outer electrode at a distance of at least 0.5 mm from the electrode walls and bottom. The principle is implemented that the rate of galvanic element deposition may be reduced by surrounding the oscillating needle contact with a system of electrodes supplied by electric current such that a sufficiently intensive electrolytic deposition takes place of substances dissolved in water on the electrodes and unwanted impurities in the vicinity of the needle contact are eliminated.

24417 Inspection approach for future reactors. *Nucl. Eng. Int.;* **21**: No. 249, 68-71(Oct 1976).

Inspection procedures and equipment design for in-service inspection of the fast breeder reactor Monju and for the advanced heavy water pressure tube reactor Fugen, are considered. Inspection of the reactor vessel, heat transport tubes of the IHX, and steam generator tubes for Monju, is briefly discussed. The safety of Fugen depends upon the integrity of the pressure components, especially the pressure tubes. The inspection methods described include volumetric inspection of the tube wall, visual inspection of the tube inner surface, creep strain monitoring of the tube inside diameter and measurement of the tube straightness.

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 24417, 24719, 24730, 24733, 24736, 24739, 24742, 24743, 24744, 24745, 24746, 24748, 24750, 24751, 24765, 24766, 24767, 24773, 24774, 24778, 24782, 24783, 24784, 24785, 24786, 24788, 24792, 24799, 24800, 24802, 24803, 24806, 24808, 24820, 24821, 24822, 24830, 24846, 24848, 24866, 25185, 25191

24418 (ANL—76-74) Germanium—lithium argon scanning system (GLASS): design and experience through 1974. Brunson, G.S. (Argonne National Lab., Ill. (USA)). Jul 1976. Contract W-31-109-ENG-38. 110p. AT.

The germanium-lithium argon scanning system (GLASS) was installed in EBR-II to monitor and analyze the gamma activity of the

reactor cover gas and the reactor building air. GLASS has the capability to identify and measure 20 or more gamma peaks. Applied to the reactor cover gas, this capability has proven useful in identifying the sources of fission-gas leakage from fuel elements. The gamma-peak data can clearly distinguish a carbide-fuel source from an oxide-fuel source and can often help distinguish an oxide-fuel source from a metallic-fuel source. The report summarizes the experience with GLASS in 1971-1974 and explains in detail the operation of the system.

24419 (ANL—8012) **Parameter studies on the effect of pulse shape on the dynamic plastic deformation of a hexagon.** Youngdahl, C.K. (Argonne National Lab., Ill. (USA)). Oct 1973. Contract W-31-109-ENG-38. 36p. Dep. NTIS $4.00.

Results of a parameter study on the dynamic plastic response of a hexagonal subassembly duct subjected to an internal pressure pulse of arbitrary shape are presented. Plastic distortion of the cross section and large-deformation geometric effects that result in redistribution of the internal forces between bending and membrane stresses in the hexagon wall are included in the analytical model. Correlation procedures are established for relating permanent plastic deformation to simple properties of the pressure pulse, for both the small- and large-deformation ranges. Characteristic response times are determined, and the dynamic load factor for large-deformation plastic response is computed.

24420 (ANL-AFP—14) **Advanced fuels program. Quarterly progress report, January—March 1975.** Kittel, J.H. (comp.). (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-ENG-38. 229p. AT.

Progress in studies on advanced LMFBR fuels is reported under the following headings: system design studies; fuel element modeling; steady-state irradiations; off-normal irradiations; reprocessing; and safety.

24421 (ANL-CT—76-40) **Extrinsic factors affecting accuracy of ultrasonic flowmeters for LMFBRs.** Managan, W.W. (Argonne National Lab., Ill. (USA)). Aug 1976. Contract W-31-109-ENG-38. 103p. Dep. NTIS $5.50.

Assuming that ultrasonic flowmeters of suitable intrinsic accuracy are feasible, this report explores factors extrinsic to the flowmeter which affect the accuracy such as asymmetric flow profile, regions of high turbulence and thermal stratification. By integrating isovelocity flow profile maps, the predicted performance of various flowmeter configurations may be compared to experimental data. For the two pipe arrangements analyzed, the single diametral path flowmeter results were within 5 percent of true flow rate. Theoretical correction factors could reduce the error for the straight pipe but increased the error for asymmetrical flow. On the same pipe arrangements a four path ultrasonic flowmeter spaced for Gaussian integration gave less than 1 percent error. For more general conclusions a range of flow profiles produced by typical LMFBR piping arrangements must be analyzed.

24422 (ANL-CT—77-2) **Pre-test predictions of radial blanket assembly heat transfer tests in sodium by the THI3D computer program.** Schmitt, R.C.; Sha, W.T. (Argonne National Lab., Ill. (USA)). Oct 1976. Contract W-31-109-ENG-38. 69p. AT.

The numerical results obtained from the THI3D computer program for a 61-pin radial blanket assembly heat transfer test in sodium are summarized. The axial computational model used in the THI3D code for a radial blanket assembly is also presented.

24423 (CONF-761007—5) **Detection of liquid metal to gas leaks in LMFBR's.** Morejon, J.A. (Atomics International Div., Canoga Park, Calif. (USA)). 1976. Contract E(04-3)-0824. 10p. Dep. NTIS $3.50.

From Conference on productivity through instrumentation and control; Houston, Texas, United States of America (USA) (10 Oct 1976).

Instruments were developed and tested to evaluate response time and sensitivity to liquid metal leaks in simulated LMFBR environments. The instruments tested include: (1) aerosol-type detectors; (2) conductivity-type detectors; (3) gas chromatograph, and (4) smoke detectors. The results from these tests indicate that the aerosol-type detectors were the most sensitive in both air and inerted environments for detection of small liquid metal leaks in the temperature range of 600°F to 1000°F. Conductivity-type detectors can be utilized for detection of larger leaks (on the order of kg/min); however, their performance for small leaks (gm/hr) is not too effective. The gas chromatograph monitored the level of H_2 gas in the test cell which was produced from the liquid metal/water reaction. Changes in the H_2 level of 10 to 15 ppM were observed during the tests conducted. A commercial type smoke detector performed well in fairly high aerosol concentrations. From the results of the tests, it is concluded that an effective system for detection of liquid metal-to-gas leaks in LMFBR's can be designed utilizing instruments and techniques readily available at this time.

24424 (CRBRP-ARD—0054) **Clinch River Breeder Reactor Plant. Predicted preliminary thermal-hydraulic performance of CRBRP fuel and blanket assemblies.** Carelli, M.D.; Bach, C.W.; Engel, F.C.; Spencer, D.R. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Aug 1976. Contract E(11-1)-2395;PMC-49-18-12-3. 91p. AT.

The thermal-hydraulic performance of the CRBR fuel and blanket assemblies was evaluated. The radial blanket assemblies shuffling scheme was selected. The fuel and blanket assemblies orificing scheme was determined on the basis of equalizing lifetime thermal performance (i.e., the maximum cladding temperature of the hottest fuel rod in the orificing zone at end-of-life conditions and burnup were considered to approximately equalize fuel rod cladding mechanical strain) and minimizing the assemblies mixed mean exit temperatures in the core central region (thus, reducing the temperatures in the upper internals structure). Relevant thermal parameters (maximum cladding and fuel temperatures, assembly mixed mean exit temperature, fission gas plenum pressure, etc.) were calculated on a core-wide basis for various Plant and lifetime conditions. Assemblies thermal performance was predicted for first and equilibrium cores at both beginning and end-of-cycle. Lifetime temperature/pressure histories for the hottest fuel rod in selected assemblies at equilibrium conditions were predicted. Predictions were made for nominal conditions and with uncertainity factors at various (0/sub sigma/, 2/sub sigma/, or 3/sub sigma/) levels of confidence. A summary of the principal thermal-hydraulic parameters of the CRBR core at equilibrium conditions is reported.

24425 (CRBRP-BCL—0160) **Clinch River Breeder Reactor Plant. Final report on CRBRP outlet plenum flow stratification study.** Carr, V.A.; Flanigan, L.J. (Battelle Columbus Labs., Ohio (USA)). Sep 1976. Contract E(11-1)-2395. 71p. AT.

To insure that the proposed design of the CRBRP outlet plenum and piping is adequate, a quantitative experimental evaluation of the effects of fluid density and flow rate changes during a scram was conducted. The report describes the flow modeling studies conducted in a 0.55-scale 1/3 sector model. The report describes the model and facility configuration along with test procedures and instrumentation. Supplemental experimental studies verifying model/facility performance are described and the experimental test run parameters detailed.

24426 (ERDA—76/146) **Summary of U.S. LMFBR programs on high temperature structural design and associated materials testing.** (Oak Ridge National Lab., Tenn. (USA)). Oct 1976. Contract W-7405-ENG-26. 129p. AT.

This document was prepared at the request of the Division of Reactor Development and Demonstration (DRDD), U.S. Energy Research and Development Administration. Four general areas of research and development are included: high-temperature structural design; irradiation effects—mechanical properties of structural materials; sodium environmental effects—influence of sodium on mechanical properties; and general material qualification.

24427 (HEDL-SA—1092(Rev.1)) **Preliminary development of inservice inspection methods for LMFBR's.** Spanner, J.C. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Mar 1976. Contract E(45-1)-2170. 20p. (CONF-760314—3). Dep. NTIS $3.50.

From Meeting on inservice-inspection and monitoring of LMFBRs; Bensberg, German Democratic Republic (9 Mar 1976).

Although firm requirements have not yet been established in the United States for inservice inspection of LMFBR's, some initial development work on potentially applicable nondestructive testing methods has been conducted by the Hanford Engineering Development Laboratory. The paper contains a synopsis of investigations conducted in each of the following areas: ultrasonic examination of austenitic stainless steel welds, electro-thermal NDT method for stainless steel components, eddy current methods for in-situ examination of heat exchanger tubes, and under-sodium viewing and ranging. Development activities and experimental results obtained to date in each of these areas are highlighted, along with comments on potential applicability for inservice inspection of LMFBR's.

24428 (HEDL-TC—133) **Sodium removal disassembly and examination of the Fermi secondary sodium pump.** Maffei, H.P.; Funk, C.W.; Ballif, J.L. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1 Aug 1974. Contract EY-76-C-14-2170. 28p. Dep. NTIS $4.00.

The Fermi secondary pump is a centrifugal single stage design. The pump had been operated more than 42,000 hours between 450 and 800°F. Sodium was drained from the pump in 1973 and the system was back filled with carbon dioxide. The pump was fabricated for 2.25 Cr-1 Mo Croloy steel. Prior to cleaning the pump was inerted and heated with 150°F nitrogen using the pump casing as the containment vessel. The water-vapor-nitrogen process was used in three increasing stages of water concentration. The hydrogen concentration in the discharge line was followed as an indicator of the sodium-water reaction rate. Upon completion of the hydrogen evolution, the pump was rinsed several times with hot water. Six pounds of sodium were removed from the pump during a process cycle of 79 hours including rinsing. The maximum pump tempera-

ture recorded was 175°F with no variation exceeding 10°F. The hydrogen concentration in the effluent provided a very satisfactory index for control of the reaction by adjustment of the water-vapor concentration feed to the system. Rinsing effectiveness was limited by a pool of water in the volute that was not drainable with the available system hook up. Sodium and its compounds were removed from all internal surfaces that could be observed by the first stage of disassembly. All such surfaces were coated with a black deposit. Areas above the sodium liquid level were coated with a vermillion colored oxide. Sodium was found on the (1) threads of the impeller nut lock screw, (2) impeller nut-tapered shaft interface, and (3) vapor deposited sodium was found in the oil seal.

24429 (HEDL-TC—157-2) **Caustic corrosion control in sodium removal processes. Part 2.** Barton, G.B.; Funk, C.W. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1976. Contract E(45-1)-2170. 50p. AT.

Standard stressed, sleeved, tensile specimens were used to investigate whether or not stress corrosion cracks were generated by the process of sodium removal by moist nitrogen (WVN process). Also the range of conditions that would induce SCC was partially explored. The WVN process can be used to remove sodium from articles of 304 SS without causing stress corrosion cracking. Cracks are generated at higher temperatures and longer times of exposure than the process requires. It appears that safe working limits can be specified.

24430 (WAPD-TM—1236) **Fission product distribution in oxide fuels (LWBR Development Program).** Berman, R.M. (Bettis Atomic Power Lab., West Mifflin, Pa. (USA)). Dec 1976. Contract EY-76-C-11-0014. 42p. Dep. NTIS $4.00.

Radial electron probe traverses were made on samples of ThO_2 and ThO_2-20 w/o UO_2 after approximately 15 and 21 x 10^{20} fissions/cm^3, respectively. Concentration profiles of ^{233}U and fission products in the thoria sample, which had not developed columnar grains, varied approximately linearly with the pellet radius. The slope of the profile varied with the volatility of the nuclide being measured; for xenon, the average concentration at the outside diameter was 6.08 percent above that at the center, and for molybdenum, it was 10.74 percent below. The slope observed for uranium did not differ significantly from zero at the 95 percent probability level. When columnar grains were developed, as in the second sample, much larger effects were superimposed on those described above. The region of the columnar grains was depleted of uranium and fission products, which tended to develop a parabolic composition profile with a minimum, at the center, one-third to one-half the average content. The material removed from the columnar grains was relocated in a band at the interface between the columnar and equiaxed grains. Technetium and the noble metals formed alloy ingots in this region with molybdenum. The composition of these ingots was not uniform; some ingots lacked one or more of the noble metals.

24431 Steam generator with circulation of coolant especially of liquid metal. Dubsek, F.; Korinek, I.; Srutek, I. Czech Patent 152,547. 15 Mar 1974. 5p. (In Czech).

A steam generator is proposed in which a recuperative heat exchanger connected to an evaporator and to an economizer is inserted in the coolant circulation, mainly the liquid metal circulation. Liquid metal which flows through the inserted recuperative heat exchanger and is cooled with water or steam of the generator is returned to the recuperative heat exchanger where it is heated. The recuperative heat exchanger is provided with a by-pass serving the temperature control of the liquid metal leaving the inserted recuperative heat exchanger. The recuperative heat exchanger may be inserted at any point of the liquid metal circulation. The aim is to achieve acceptable temperature gradients on heat-transfer surfaces, to simplify the selection of suitable steel, and to avoid heat-transfer surface accidents resulting from heat stress, pulsations and corrosion by water and sodium.

24432 Fuel-assembly supporting rod for nuclear reactor grids. Venot, Robert (Groupement pour les Activites Atomiques et Avancees (GAAA), 92 - Le Plessis-Robinson (France)); Gallet, Bernard (Societe Technique pour l'Energie Atomique (Technicatome), Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). (to CEA). French Patent 2,274,995/A/. 12 Jun 1974. 12p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

Description is given of a fuel-assembly supporting-rod for nuclear reactor grids, comprising a hollow cylindrical body, integral with the grid and passing through the upper part thereof so as to receive a fuel-assembly leg vertically supported by the grid, and a removable sleeve mounted in a head coaxially extending said hollow body, the sleeve comprising a sealing conical bearing surface for centering the assembly. Said supporting-rod is characterized in that the removable sleeve and the supporting-rod head are mutually engaged and made integral with each other by a removable welded connection arranged in an annular zone coaxial with the sleeve. This can be applied to fast nuclear reactors.

24433 Waves propagation effects on dynamic loading. Albertini, C.; Montagnani, M. (Commission of the European Communities, Ispra (Italy). Joint Research Centre). pp vp, Paper E4/4 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24434 Low-cycle fatigue in a convolution bellow. Curioni, S. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy)). pp 13p, Paper F6/8 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The core central area of PEC is occupied by a loop; in this loop cooled by a separate circuit, it is possible to introduce an experimental fuel element. For safety reasons it is necessary to use double containment for the test loop and this requirement is being met by using double wall construction for both the inlet leg and the outlet test leg. Since the inside and outside walls of each leg are subjected to changing thermal environments along the axial length, there is differential thermal expansion between two walls. It is therefore necessary to install some bellows. During the normal operations these bellows must support only the differential thermal expansion between the two coaxial tubes and there is no pressure acting on the bellows. In an accidental condition, as a rupture in the internal pipe, the gap between the two tubes is invaded by sodium. In this condition the external bellow supports the loop coolant pump pressure and it is important for plant safety to investigate the endurance as a function of the number of deformation cycles supported by the bellows. A special machine has been designed and constructed in order to carry out the indicated tests. The results show that the burst pressure is strongly affected by the displacement amplitude. The energy absorbed by the bellows at the rupture is very low; before the rupture (due to internal pressure) there is a shape deformation and a convolution removal. The new shape assumed depends on the bellow instability and therefore on the internal pipe constraints; a different gap between the internal pipe and the bellow changes the results.

24435 Vibration of a distorted circular cylinder containing liquid. Firth, D. (UKAEA Reactor Group, Risley). pp 8p, Paper F2/10 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

This paper is concerned with an attempt to explain some unexpected features which occurred during an investigation into the coupling between an acoustic field in the liquid contained in a shell and the vibrations of the shell itself. This work arose from the development of the Prototype Fast Reactor, in particular the need for ability to estimate the magnitude of vibrations of the primary tank when excited acoustically by the liquid sodium pumps. The vibration modes of a liquid-filled circular cylindrical shell were studied theoretically and experimentally, and reasonable agreement was obtained for the resonant frequencies. However, by experiment it was found that when the liquid was excited in a symmetric (i.e. $n=0$) mode, the structure vibrated in short-wavelength ($n<0$) flexural modes, with significant amplitudes in some cases. Since the presence of such waves is not predicted by simple theory, no estimate of the relative amplitudes of the modes could be given. The theory outlined here relates the production of short-wavelength flexural waves in a circular cylindrical shell containing liquid which is excited acoustically, to the initial geometrical distortions present in the shell (e.g. the departures from circularity). The results of some numerical calculations are compared with experimental data.

24436 Internal pressure buckling of very thin torispherical shells. A comparison of experiment and theory. Galletly, G.D. (Liverpool Univ. (UK). Dept. of Mechanical Engineering). pp 10p, Paper G2/3 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The bottom head of the primary vessel of some LMFBR's is a thin torispherical shell. The internal pressure loading on the head consists of the weight of the sodium contents plus any superimposed gas pressure. Depending on the design of the bottom head, it can fail by (i) elastic or elastic-plastic circumferential buckling or (ii) the development of yield 'hinges' and gross deformation of the shell. At the present time, there is no generally-accepted theory of asymmetric elastic-plastic shell buckling due to internal pressure. However, the experimental-theoretical correlation for external pressure buck-

ling looks promising-as evidenced by the recent paper by Bushnell and Galletly. In this paper a review is given of previous work on internal pressure buckling of torispheres-some of it of very recent origin. The author's experiments on a limited number of machined, stress-relieved, cylinder-torisphere combinations which were subjected to increasing internal pressure are then described.

24437 Generalized hydrodynamic effects of a double annuli on a vibrating cylindrical shell. Penzes, L.E.; Bhat, S.K. (General Atomic Co., San Diego, Calif. (USA)). pp 12p, Paper F2/6 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The theory of generalized pressure and virtual mass effects of an outer and an inner annulus of liquid (or gas) on a vibrating orthotropic cylindrical shell is developed. General boundary conditions are used for the liquid (or gas) and for the shell. This theory is further extended to the problem of dynamic behavior of Gas-Cooled Fast Breeder Reactor shields.

24438 Studies to single subassembly flow monitoring with a complete 7 element array under sodium. Hess, B.; Ruppert, E.; Stehle, H.; Vinzens, K. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bensberg/Koeln (Germany, F.R.)). pp D1/10 1-12 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

A core restraint system in a fast reactor serves to limit fuel element movement leading to reactivity changes and misalignment of control rod drives and instrumentation. To guarantee proper control rod function the upper ring of the passive restraint system for the SNR-300 should keep subassembly displacement below 20 mm, whereas a free bowing up to 25 mm does not impair subassembly handling. With respect to single subassembly instrumentation the influences of subassembly displacement on temperature and flow monitoring were not exactly known. As part of the SNR-300 R and D programme a complete clamped array, consisting of 4 full size fuel elements and 3 blanket elements was tested for more than 4000 hours at 600°C in the AKB sodium loop at Interatom, Bensberg. The test was split into two phases and the total cluster was prestrained in the second phase to simulate 15 mm subassembly displacement at the level of the upper pads. Although this test was mainly considered as an endurance test to demonstrate the integrity of prestrained core elements, effort were made to study the feasibility of single subassembly flow monitoring with this full size model of a core section.

24439 Response of single LMFBR type hexcans to static and dynamic loads - some experiments and analysis. Ash, J.E.; Marciniak, T.J. (Argonne National Lab., Ill. (USA)); Cagliostro, D.J. (Stanford Research Inst., Menlo Park, Calif. (USA)). pp E2/4 1-14 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Determination of the structural response of Liquid Metal Fast Breeder Reactor (LMFBR) subassembly ducts to postulated local energy releases is a complex problem. In order to minimize the uncertainties involved in predicting the structural response, an analytical and experimental effort has been undertaken to devise computational techniques valid over a wide range of postulated events and material properties. The effort centers mainly upon an out-of-pile experimental program which has been devised and is being carried out to verify and extend finite-element computer codes designed to evaluate duct response under reactor operating conditions. In order to verify the finite-element codes, a series of experiments has been performed under quasi-static and dynamic conditions. The deformation over the uniform range corresponds to two-dimensional plane-strain conditions, and a two-dimensional computer code can be applied for the analysis. Additional tests were then performed using a series of type 316 stainless steel hexcan specimens in which the ductility was varied from a fully annealed specimen to brittle specimen with a hardness corresponding to 50% cold working. Dynamic tests of hexcans were also performed using a pressure-time source designed to duplicate a postulated local event.

24440 LMFBR model for combined studies of flow and acoustic vibrations. Bentley, P.G.; Collinson, A.E.; Firth, D.; Taylor, A.F. (UKAEA Reactor Group, Risley). pp F2/11 1-10 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The paper summarises a study which has been carried out to determine whether a hydroelastic model using water can be built to reproduce realistically combined flow and acoustic induced vibration amplitudes. This problem is examined in three parts. Firstly the driving forces are considered which are entirely a function of the fluid, and simple mathematical equations are derived which include the geometrical scale, velocity scale, and frequency scale. These equations can be simultaneously satisfied and they determine the absolute values of the principal scales. For example the geometrical scale must be 0.392. Later in the paper the detailed effects of departing from these ideal values are considered. Secondly the structure is examined to see how it should be designed to have the correct resonant frequencies. This is most important because some of the driving forces are sinusoidal or narrow band random so that maximum vibration is critically dependent on the coincidence of driving frequency and structural resonance frequency. Thirdly the vibration amplitudes at resonance are checked. There is no freedom to adjust the design at this point since all aspects are determined by the previous arguments.

24441 Fracture mechanics contribution to fuel element design and analysis. Chopra, P.S.; Wu, T.S.; Hofman, G.L. (Argonne National Lab., Ill. (USA)). pp C4/1 1-10 of In Structural mechanics in reactor technology. Vol. 1. Jaegar, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The paper demonstrates the usefulness of a finite element fracture mechanics technique for evaluating the structural integrity of fast breeder reactor fuel element cladding. In an earlier work, Chopra presented a technique for analyzing the creep rupture of fuel element cladding based upon linear elastic finite element solutions for strain energy release rates and stress intensity factors. Finite element solutions are presented which include the influence of material non-linearity due to creep plastic deformation.

24442 Limiting conditions for structural integrity of components under fast breeder reactor core environment. Chopra, P.S.; Bottcher, J.H.; Lambert, J.D.B.; Hofman, G.L. (Argonne National Lab., Ill. (USA)). pp E2/6 1-12 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The study focuses upon the influence of the fast breeder reactor core environment on the resultant useful service-life and load carrying capability of core components of the Experimental Breeder Reactor II (EBR-II). Specific examples selected are: (i) the dynamic response of a single hexagonal subassembly can to a potential pressure pulse resulting from a failed fuel element cladding: (ii) interaction between a fuel element cluster and its surrounding subassembly can: (iii) the interaction between adjacent subassemblies, and (iv) the influence of swelling and pressure induced stresses on the grid plenum assembly. Results of core surveillance efforts, experimental investigations, and analyses completed to date by several EBR-II investigators are presented. The study demonstrates the significance of fast breeder reactor core operating conditions in determining the safe limiting conditions for core structural components.

24443 Bowing stability of the peripheral pins in fast reactor subassemblies. Cornet, G.; Capart, G. (Societe Belge pour l'Industrie Nucleaire, Brussels). pp D1/8 1-12 of In Structural mechanis in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The azimuthal temperature gradients around the peripheral fuel pins in core subassemblies give rise to deflections of these pins, because of the differential thermal and void-swelling expansion of the cladding material. The fuel-pin deflections in the core region have a direct influence on the coolant temperature distribution which is in general in the sense of increasing the gradients thereby leading to further deflections. Whether or not this feedback process converges to a stable bowing configuration depends on the sensitivity of the deflections and of the temperature gradients to each other. The paper presents a first approach to the study of the bowing stability. The definition of two models is first required; a thermohydraulic model describing the influence of the bowing deflections on the coolant temperatures in the surrounding subchannels and the resulting changes in the azimuthal temperature gradients; a mechanical model describing the bowing response of the fuel pins to any change in the azimuthal temperature gradients. The two models are then combined in a feedback system. The results of the analysis are applied to a typical fuel subassembly and are translated into a criterion limiting the maximum allowable axial spacing between the spacer grids in the core region.

24444 Modelling techniques for the assessment of fast reactor vibration characteristics. Durrans, R.F.; Hammill, W.J.; Whitton, P.N. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). pp F1/2 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24445 Measurement and analysis of vibrational behaviour of an SNR-fuel element in sodium flow. Hess, B.F.H.; Ruppert, E.; Schmidt, H.; Vinzens, K. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bensberg/Koeln (Germany, F.R.)). pp D2/9 1-12 of In Structural mechanis in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Within the framework of SNR-300 fuel element development programme a complete full size fuel element dummy has been tested thoroughly for nearly 3000 hours at 650° C system temperature in the AKB sodium loop at Interatom, Bensberg. Investigations of the hydraulic characteristics by measurements of specific pressure losses, flow velocities, leakage flow through the piston rings, and investigations of its vibrational behaviour were part of this endurance test at elevated temperatures. The pressure drop versus flow and the leakage measurement are mentioned briefly to confirm the correctness of the test hydraulics. The vibrational behaviour of the element and the approach to analysis is the main object of the report.

24446 Plastic dynamic analysis of liquid metal cooled reactor components. Use of CEA-SEMT system. Hoffmann, A.; Goldstein, S.; Roche, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service des Etudes Mecaniques et Thermiques); Gerij, J.; Thomas, B. (Societe Technique pour l'Energie Atomique (Technicatome), Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). pp F4/4 1-12 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The development of a liquid metal fast reactor implies the ability of designed structures to stand up successfully to highly improbable accidental circumstances. Moreover, it is useful to know the ultimate loading that the various components can stand. Behaviour of the mechanical structures in the event of sudden accidents such as very strong and rapid pressure evolutions must be known. Given such high loads and considering the material characteristics (low yield stress, high elongation capacity, high strain hardening) the analysis must account chiefly for no linear dynamic phenomena involving plasticity and high distortions. The CEA-SEMT system of structures calculation by finite elements has been used extensively for this analysis. It allows static and dynamic calculations in the plastic (and of course elastic) range with large deformations. It includes isotropic and kinematic hardening models. Indications are given on real plastic and dynamic analysis performed by that system for various components of the French LMFR project.

24447 Creep strain accumulation in a typical LMFBR piperun. Johnstone, T.L. (UKAEA Reactor Group, Risley). pp F3/7 1-12 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Elastic strains generated by the restraint of thermal expansion of a pipe run operating in the creep regime are inexorably converted into permanent strains. Depending on the extent of elastic follow up inherent in the pipework, transfer of strain energy to the most highly stressed components can occur leading to localised creep strains several times in excess of those predicted elastically. The analysis described allows the strain concentrations in typical LMFBR two anchor point uniplanar piperuns to be calculated. Account is taken of the effect of pipe elbows in attracting creep strain to themselves as well as possible movements of the thrust line due to strain redistribution. The influence of the initial load conditions is also examined.

24448 Application of finite element method to thermal contact problem and experiments in fast reactor. Miya, K.; Hashimoto, M. (Tokyo Univ. (Japan). Nuclear Engineering Research Lab.); Ando, Y. (Tokyo Univ. (Japan). Faculty of Engineering). pp C3/8 1-12 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Cylindrical elements are used in many reactors, principally in fuel elements. A number of such fuel elements are solid with external cladding. A mechanical fuel-cladding interaction has recently become to be an important problem from a viewpoint of safety analysis against cracking and thermal deformation of fuel elements. Temperature distribution in the fuel and the cladding should be generally given prior to solving the mechanical interaction of the fuel-cladding. Analytical solutions for such problems can not be easily deduced and therefore the finite element method which is applicable to various types of boundary problems may be also a powerful means for it. The paper deals with the transient thermal contact problem of the fuel-cladding using the finite element method.

24449 LMFBR steam generator tubing design selection through fault tree analysis. Morales, W.J. (Westinghouse Electric Corp., Tampa, Fla. (USA). Tampa Div.). pp F7/2 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

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24450 Preliminary survey of reliability analysis of LMFBR primary coolant system piping. Okabayashi, K. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). pp F3/5 1-10 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

One of the significant problems in the safety evaluation of the loop-type LMFBR is whether the severance of the primary coolant system pipe should be postulated as an initiating event of the Design Basis Accident as in the case of light water reactors. The author reports the preliminary survey of the reliability analysis of the cold leg pipes of the primary coolant system of the 300 MWe class loop-type LMFBR, where the occurrence of the severance is significant in the view-point of the safety design but the creep behavior of the materials could be neglected. The first part of the survey is that of the present status of the operating conditions, design method, material, fabrication, inspection, and quality assurance of the piping system, to pick up the essential values in the probabilistic evaluation of the severance. The second part of the survey is the trial to draw the fault tree to the severance of the piping system which consists of two stages. The first stage is the probabilistic evaluation of the potential 'damage conditions' which are caused by the low-cycle fatigue throughout the life time of the reactor. The second stage is the evaluation of the occurrence of the severance when the extreme loads with low probability are loaded to the piping system in the 'damaged conditions'.

24451 Intermediate heat exchanger project for Super Phenix. Roumailhac, J. (Societe Technique pour l'Energie Atomique (Technicatome), Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)); Desir, D. (Groupement pour les Activites Atomiques et Avancees (GAAA), 92 - Le Plessis-Robinson (France)). pp F7/1 1-10 of In Structural mechanics in reactor technology. Vol. 2. Jaeger. T.A. (comp.). Amsterdam; North-Holland (1975). (In French)

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The Super Phenix intermediate heat exchangers are derived directly from those of Phenix which has been in operation at Marcoule for two years. The exchanger tube bundle is very similar for both reactors, and design studies have proved that this concept, based on experience gained in Phenix plan construction, was able to achieve the required operating conditions. The characteristics related to reactor pool-type design are presented. Thermal, hydraulic, and mechanical considerations are presented.

24452 Design considerations for nuclear fuel elements to suit reactor operating in small electrical grids. Rustagi, R.S.; Das, M. (Department of Atomic Energy, Bombay (India). Power Projects Engineering Div.). pp D1/9 1-12 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The 220 MWe Candu-PHW unit of the Rajasthan Atomic Power Station (RAPS) has experienced to-date over 130 reactor trips, shut downs, or power cut-backs, as against a total of 100 planned and unplanned outages specified in the fuel design specification. Majority of these power cycles are ascribed to either class IV power failures or severe grid frequency swings. To overcome these problems, consideration is also being given for replacing existing turbine-follow-reactor philosophy by a modified reactor-follow-turbine control scheme. As such, in addition to power cycles associated with outages, the reactor is likely to experience daily cycling of some power level. The objectives set out for the study were (i) to examine whether or not the current fuel of the wire-wrap design will survive power cycles (which may exceed 300 for the start-up charge) and (ii) to evolve fuel design modifications, so that power cycling does not become a performance limitation.

24453 Structural analysis and stress criteria of advanced LMFBR-fuel element components. Seehafer, H.J. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bensberg/Koeln (Germany, F.R.)). pp D1/2 1-11 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The fuel subassemblies for the 1st load of the SNR-300 use grids for fuel pin spacing. These grids are axially fixed by three tie rods. As the use of tie rods in the core means a loss of reactor power, new grid attachment concepts have been developed within the SNR-project providing the attachment of the grids at the wrapper tubes. The main purpose of the report is to describe the mechanical design procedure for grid spacers, to find out the most promising grid attachment, and to investigate the influence of uncertain conditions on the stress level in grid spacers. Furthermore the stress which is expected to relax due to irradiation induced creep has been estimated.

24454 Theoretical and experimental analysis of a sodium cooled nuclear reactor nozzle loaded by thermal shocks. Spaas, H.A.C.M. (Delft Univ. of Technology (Netherlands). Lab. for Thermal Power and Nuclear Engineering); Miyazono, S.; Kodaira, T. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment); Ito, K. (Power Reactor and Nuclear Fuel Development Corp., Oarai, Ibaraki (Japan). Oarai Engineering Center). pp G1/5 1-10 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

During transient conditions (starts, stops, scram) severe thermal shocks may occur at the inner surfaces of inlet and outlet nozzles of vessels for sodium-cooled fast breeder reactors. However, only few experimental and analytical data are available about the detailed transient temperature, stress, and strain distributions. In an earlier paper test results were given of experimental temperature and strain data as obtained from thermal shock tests on a nozzle model in a sodium test loop. Because of the limited number of data points and the complexity of the problem the interpretation of these experimental results in terms of thermal shock resistance and design rules was found very difficult and has formed the subject of a separate study whose results are reported in combination with results obtained from a finite element analysis.

24455 Experimental analysis on piping components of fast breeder reactors. Vrillon, B. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service des Etudes Mecaniques et Thermiques); Montfort, C. (Bureau Veritas, 75 - Paris (France)); Befre, J. (Technicatome, Gif-sur-Yvette, France). pp F3/4 1-11 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

A991694 experimental study supplemented by resistance calculations using the finite method was carried out on an elbow bend and a T-junction of the intermediate sodium circuit of the Phenix reactor. The purpose of this work was to adjust the methods of calculating these relatively thin austenitic steel sheet components in view to checking their resistance towards bending moments especially those due to earthquake effects.

24456 Measurement of moisture motion under a temperature gradient in a concrete for SNR-300 using thermal neutrons. Zeilinger, A. (Atominstitut der Oesterreichischen Hochschulen, Vienna); Huebner, R. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bensberg/Koeln (Germany, F.R.)). pp H1/9 1-11 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

For describing the behaviour of the moisture in the concrete of the containment of SNR-300 in a hypothetical accident parameters were determined experimentally. The method is based on transmission of thermal neutrons through a plate of concrete. When a temperature of 170°C was applied at one end of the plate migration of moisture and evaporation took place. This could be observed by neutron radiography giving a gross picture of moisture migration. The intensity of the transmitted neutron beam was measured with a neutron counter. From these values profiles of the change of moisture concentration could be obtained with a spatial resolution of a few millimeters. The method used is entirely different from the conventional moisture meters which use fast neutrons. From the experimental data the mass transfer coefficient of vapour, the diffusion coefficient of vapour in concrete, and the porosity of the concrete could be determined.

24457 Fast breeding nuclear reactor installation. (to Neratoom N.V.). Netherlands Patent 7,500,450/A/. 15 Jan 1975. 9p. (In Dutch).

5 figs.

The patent describes a closed-cycle cooling system for a fast-breeding nuclear reactor. The cooling flow is divided into two parts; one for the reactor core and one for the breeding section. A special feature of this system is that the outlet flow from the breeding section is mixed with the inlet for the reactor core.

24458 Device for positioning and locking fuel elements in a nuclear reactor. Frick, T.M.; Wineman, A.L. (to Energy Research and Development Administration). French Patent 2,279,199/A/. 15 Jul 1975. 11p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 15 Jul 1974, US.

The device according to the invention is characterized in that each fuel-element comprises a fuel-rod with a plug at the lower end thereof, each of said plugs comprising a key-slot with an enlarged portion, a positioning and locking rod provided with notches being slidingly engaged through the key-slots, the assembly being mounted on a thin-walled fastening block provided with key-slots for a fixing rod slidingly engaged through the latter slots and the slots of each row of fuel elements, the thus-formed assembly being engaged in the respective core channel. Such a device is suitable in particular for a fast breeder reactor.

24459 Performance analysis of the small leak detection system in a sodium-heated steam generator. Nikai, I.; Komiyama, T.; Kanegae, N. (Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan)). *Ishikawajima-Harima Giho;* **15**: No. 6, 671-679(Nov 1975). (In Japanese).

A programing code called "KONIKA" for performance analysis of the in-sodium hydrogen detection system, a component of the small-leak detection system for sodium-heated steam generators, has been developed by IHI. Using this code, the performances of a steam generator designed for an imaginary fast breeder reactor of a prototype class system consisting of three lines of the evaporator-superheater-reheater subsystems were simulated under varied operation conditions, such as different operation stages, power levels, leak locations, and detector sensitivity levels. As a result, the following has been clarified. 1. Under the operation conditions given, the time during which the system can be operated safely is shortened, if a leak occurs in the evaporator during the early stage of the start-up operation. 2. Provided the steam generator system is in the steady state operation, leaks can be detected in the low leak rate range and the system can be shut down before surrounding heat transfer tubes are damaged.

24460 Development of electromagnetic flow meter for liquid sodium for fast breeder reactors. Yamada, K.; Iwamoto, S. (Mitsubishi Heavy Industries Ltd., Kobe (Japan). Kobe Shipbuilding and Engine Works). *Mitsubishi Juko Giho;* **12**: No. 6, 674-679(Nov 1975). (In Japanese).

Mitsubishi Heavy Industries has developed a large-bore electromagnetic flow meter for liquid sodium to be used in fast breeder reactors in cooperation with Shimadzu Seisakusho, Ltd. In designing the flow meter, a minute study was made on the construction which would exactly conform to the theory of electromagnetic flow meter and as its result, adopted the saddle-shaped coil-excited type. Furthermore, in order to examine the accuracy of the dry calibration by large-bore electromagnetic flow meter, a calibration test was performed on the flow meter by use of liquid sodium. It obtained a high accuracy well comparable with that obtained by the test loop. This paper describes the method of magnetic field calculation, the field measuring method and the dry calibration technique for flow characteristics. It also refers to the problem involved in the electromagnetic flow meters with larger bores for highspeed breeder reactors which will be produced in the future.

24461 Development of steel tubes for steam generator of fast breeder reactor. Yukitoshi, T.; Moroishi, T.; Koizumi, I.; Abe, T.; Yoshikawa, K. (Sumitomo Metal Industries Ltd., Amagasaki, Hyogo (Japan). Central Research Labs.). *Nippon Genshiryoku Gakkaishi;* **17**: No. 12, 667-673(Dec 1975). (In Japanese).

Test tubes of 2 1/4Cr-1Mo and its modification grades for steam generators of fast breeder reactors were produced by the commercial tube manufacturing processes, and mechanical properties, high temperature strength, decarburization behavior and weldability were investigated. Normalized and tempered 2 1/4Cr-1Mo steel, and 2 1/4Cr-1Mo-Nb-Ni steel when minimizing of decarburization is especially important, are recommended. The former has been used for conventional boiler tubes with good performance. Its decarburization behavior in sodium varies with metallographical structures and type of carbides, and decarburization can be suppressed sufficiently when the steel is heat-treated by appropriate normalizing and tempering instead of usual annealing. The latter was confirmed to be and its creep rupture strength is higher than that of 2 1/4Cr-1Mo steel below the temperatures of 500°–520°C. Short time tensile strength of 2 1/4Cr-1Mo steel normalized at 950°C and tempered was sufficient due to bainitic structure. As to weldability, severe precautions including preheat above 150°–200°C and full penetration at the welding are required, though it is common to all the niobium stabilized steel. In order to improve the lower toughness in weld joint post heat-treatment is necessary.

24462 (ERDA-tr—252) Safety of oxide fuel elements of the fast neutron type. Ollier, H.; Truffert, J. Translated from *Bull. Inf. Sci. Tech. (Paris);* No. 210, 33-39(1976). 11p. Dep. NTIS $3.50.

Studies leading to the definition of a fuel element and instructions for its use overlap with safety studies to the extent that they must guarantee, for nominal running conditions, a failure rate consistent with the working rules of the Station. Given the present state of knowledge on the causes and kinetics of damage affecting the cladding, this report deals mainly with the principles of this research. The advantages of applying statistical computing methods to the two factors which govern the lifetime of the pins, their working conditions and quality, are demonstrated.

24463 Gas entrainment problems in sodium cooled nuclear reactors. Aubert, M. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France). Service d'Etude et de Developpement de la Technologie des Reacteurs a Sodium); Merle, M. (Alsthom, 38 - Grenoble (France). Div. Neyrpic). pp 293-304 of In Ecoulements diphasiques et cavitation dans les systemes de production d'energie. Paris; Societe Hydrotechnique de France (1976). (In French)

From Symposium on two phase flow and cavitation in power generation systems; Grenoble, France (30 Mar 1976).

A brief description is given of the sodium-cooled nuclear reactor and of problems arising when gas is entrained into the primary circuit. Places where gas entrainment may occur are identified; observations made on operational reactors are reported, and present trends relating to gas entrainment are discussed. An example is given of a solution proposed to reduce the amount of entrained gas; the development work and salient results are presented.

24464 Similitude between cavitating water or sodium. Bisci, R.; Courbiere, P. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France). Dept. des Reacteurs a Neutrons Rapides). pp 371-382 of In Ecoulements diphasiques et cavitation dans les systemes de production d'energie. Paris; Societe Hydrotechnique de France (1976). (In French)

From Symposium on two phase flow and cavitation in power generation systems; Grenoble, France (30 Mar 1976).

A description of the main features of French Atomic Energy Commission's program in the field of cavitation is followed by a presentation of means for tests and measurements for these investigations. Specially concerned are the comparison of cavitation inception in sodium as compared to water and effects of prolonged cavitation on sodium reactor equipments. The first results of tests on a diaphragm (20 in diameter) carried out in a sodium cavitation tunnel are included. Similar results in water flow shall be presented later.

24465 High burnup performance of LMFBR fuel rods - recent GE experience. Hilbert, R.F.; Aitken, E.A.; Pluta, P.R. (General Electric Co., Sunnyvale, Calif. (USA). Breeder Reactor Dept.). *Ann. Nucl. Energy;* **3**: No. 5;6, 297-304(1976).

From European nuclear conference; Paris, France (Apr 1975).

A series of tests designed to evaluate the high burnup irradiation performance of mixed oxide fuel rods has achieved substantial burnup in EBR-II without incidence of failure. Several stainless steel cladding alloys and fuel configurations were irradiated over a broad range of operating conditions up to 16.3 at.% burnup, 47 kW/m linear power, and 570°C cladding temperature. Extensive examination showed the rods to be in good condition after extended operation in both loose and tight wire wrap spaced assembly configurations. In fuel rods with typical near-term LMFBR design parameters, cladding inelastic strains in the range from 0.3 to 0.8% were commonly observed at about 10 atom % burnup. The inelastic strain appears to increase with burnup and fluence, with the possibility of threshold values for these variables. Preliminary analyses suggest that the cladding inelastic strain was not entirely caused by pressure from released fission gases. Microstructural examinations indicated good fuel-cladding chemical compatibility and comparable behaviour for both physically-mixed and coprecipitated fuel. Significant results include the observation of negligible fuel-cladding gap in low power fuel at approximately atom % burnup, and partial closure of the central void in annular fuel approximately 10 atom % burnup.

24466 Sodium-water reaction test facility (SWAT-3). *Ishikawajima-Harima Giho;* **16**: No. 1, 78-87(Jan 1976). (In Japanese).

In the development of the liquid metal cooled fast breeder reactor (LMFBR), the steam generator (SG) is considered one of the most important components. The Power Reactor and Nuclear Fuel Development Corporation (PNC) is now promoting the research and development of the SG system used with the prototype fast breeder reactor "Monju". In this research, the phenomena of the sodium-water reaction in the SG are the keys which must be investigated for the solution of problems. The test facility (SWAT-3) simulating Monju's SG on the scale of 1/2.5 was designed, fabricated and installed by IHI at Oarai Engineering Center of PNC, its preoperation being accomplished in February 1975. The purpose of SWAT-3 is summarized as follows: (1) To perform an overall test on the safety of Monju's SG and intermediate heat transport system under the design condition against sodium-water reaction accidents. (2) To investigate the damage of the SG structure caused by the sodium-water reaction, and the possibility of repair and recovery operations. The first test was accomplished successfully on June 9, 1975. As a result of the test, the fundamental function of this test facility was proven to be satisfactory.

24467 Coolant recirculation pump drawing in from a sump for the primary coolant loop of liquid-metal cooled nuclear reactors. Mangus, J.D. (to Westinghouse Electric Corp.). German(FRG) Patent 2,525,157/A/. 5 Feb 1976. 23p. (In German).

4 figs. Available from Dt. Patentamt, Muenchen (FRG).

The proposal relates to the improvement of a coolant recirculation pump drawing in from a sump for the primary coolant loop of a liquid-metal (e.g. Na) cooled nuclear reactor. The pump sump divided into upper and lower chambers by means of a partition has a throttled connection between pump outlet and upper chamber, which connection serves for maintenance of a predetermined liquid level in the upper chamber and makes it possible to maintain the top gas pressure in the sump at a level substantially identical with the top gas presssure in the reactor vessel. Various designs of the throttled connection are provided, including the feature that the throttled connection has a variable throttle opening.

24468 Fuel element cluster of a nuclear reactor. Kurilkin, W.W.; Kusmartsew, E.W. German(FRG) Patent 2,443,018/A/. 25 Mar 1976. 15p. (In German).

8 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention deals with spacers for fuel element clusters in liquid-metal cooled fast reactors. To prevent possible deformations at high speed due to swelling, it is proposed to reinforce the wire wound spirally around the cladding tube of each fuel element as a spacer with two additional wires, thus producing a wire bundle rigidly connected on the sections between the contact levels.

24469 Fast breeder reactor. Kowin, W.M.; Mitenkow, F.M.; Owetschkin, A.W.; Pankratow, W.A.; Sawin, N.I.; Ternikowa, T.A.; Filippow, W.J.; Chramow, D.A.; Tschernomordik, E.N.; Schiryaew, W.I. German(FRG) Patent 2,443,961/A/. 1 Apr 1976. 17p. (In German).

4 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention deals with the structural design of a reactor vessel for a fast breeder reactor. It has the objective to achieve higher strength of the vessel and a better temperature distribution within it. It is proposed to design the reactor vessel as a cylinder (with circular cross section) with horizontal longitudinal axis which has collars for the contact liquid metal/inert gas. The design is described in detail.

24470 Device for sampling out of a liquid metal loop. Weiss, H.; Cremer, D.; Kranz, E. (to Internationale Atomreaktorbau G.m.b.H. (INTERATOM)). German(FRG) Patent 2,443,559/A/. 1 Apr 1976. 17p. (In German).

2 figs. Available from Dt. Patentamt, Muenchen (FRG).

Perfect sampling of liquid metals (Na) from a circuit - especially in nuclear reactors - is still a problem. The inventors therefore propose improvements in the sampler, dealing in particular with the admission line for the metal its even distribution in the test pans by means of a deflector, the pan holders and the design of a distillation unit in the sampling vessel formed as a heating spiral. The proposal is illustrated by a practical example.

24471 Liquid metal cooled or gas cooled fast breeder reactor. Klein, K.W.; Rau, P. (to Siemens AG). German(FRG) Patent 2,042,736/B/. 29 Jul 1976. 3p. (In German).

5 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention relates to a fast breeder, in which at least part of the fuel or breeding elements arranged in core regions with high neutron flow gradients are provided with means which are to prevent fuel rod deformations caused by non-uniform material swelling. According to the invention, such means may be: metallic or ceramic bodies which substitute the fuel or breeding material in the elements. Hinges of very restricted movability on the jackets of the fuel elements in the field of maximum neutron flow gradients. The different designs are illustrated by examples.

24472 Agreement between the United States Energy Research and Development Administration and the Federal Minister for Research and Technology of the Federal Republic of Germany in the field of liquid metal-cooled fast breeder reactors. *Bundesgesetzblatt, Teil 2;* No. 46, 1448-1458(Aug 1976). (In German, English).

Text of the Agreement in English and German which entered into force according to its article 18 on 8th June 1976. The Agreement was concluded because the parties 1) have a mutual interest in developing the LMFBR, 2) recognize the important roles of both ERDA and the BMFT in such research and development, 3) believe that the solution to problems of obtaining energy from the LMFBR should also provide for an amelioration of environmental problems, and 4) because they recognize the need to establish procedures governing the protection of privileged information.

24473 Sodium cooled nuclear reactor. Lievense, K. van. (to Neratoom, N.V.). German(FRG) Patent 2,504,496/A/. 5 Aug 1976. 17p. (In German).

3 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention refers to the storing of the core of a sodium-cooled reactor. The core is placed in a tank containing liquid sodium and is movably arranged on one or more hydrostatic bearings. The sodium of the reactor coolant is used as liquid for the bearings. The hydrostatic bearings consist of a pressure plate arranged in a chamber. The chamber has a curved outer surface. The bearings are supporting the core only when the core has to be shifted.

24474 LMFBR fuel pin behaviour: a limited parameter survey using the code FRUMP. Grosberg, A.J. (Imperial Coll. of Science and Technology, London (UK)). *J. Inst. Nucl. Eng.;* **17**: No. 5, 120-122(Sep 1976).

A description is given of the results obtained using the FRUMP computer code (fast reactor unrestricted modelling program) which has been developed at UKAEA Harwell to model the behaviour of a fast reactor fuel pin. This is a one-dimensional code which assum es axial symmetry and plain strain. The user must input the fuel pin parameters required, which in the case of the fast reactor comprises a mixed oxide fuel with a central void surrounded by a small initial gap and stainless steel cladding. The user must also provide the outer clad temperature and a rating time relationship for the pin. The program takes into account fuel and cladding swelling, creep, porosity migration, fission gas release, and fuel cracking. It proceeds in marching time step fashion to calculate at each step the three-dimensional stress and strain distributions, the temperature distribution, and the radial displacements. The code regulates the step length by referring to accuracy criteria, thus keeping the numerical errors minimal. Cases are described illustrating the range of conditions that might occur in a fast reactor core.

24475 Influence of reactor design on the establishment of natural circulation in pool-type LMFBR. Durham, M.E. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). *J. Br. Nucl. Energy Soc.;* **15**: No. 4, CS; LMFBR TYPE REACTORS; M CODES; NATURAL CONVECTION; POOL TYPE REACTORS; PRIMARY COOLANT CIRCUITS; PUMPS; TEMPERATURE DEPENDENCE(Oct 1976).

24476 UK set for early experience with complete fast reactor cycle. Masters, R. *Nucl. Eng. Int.;* **21**: No. 249, 41-42(Oct 1976).

The fast reactor programme continues to take the largest share of the U.K.A.E.A.'s resources. Expenditure was over Pound49M in 1975-76. Progress on the PFR, CFR and associated fuel cycle are reviewed in the latest annual report.

24477 Hydrogen and oxygen behavior in liquid sodium (experimental). Katsuta, H.; Furukawa, K. (Japan Atomic Energy Research Inst., Tokai). *Nucl. Technol.;* **31**: No. 2, 218-231(Nov 1976).

Hydrogen and oxygen behavior in a sodium test loop similar to the sodium-cooled fast breeder reactor were examined. Hydrogen partial pressure equilibrated to the sodium was measured by a membrane-permeation-type hydrogen-meter. An electrochemical oxygen-meter was used to determine the oxygen activity. The measured hydrogen pressure was converted to the hydrogen concentration through the Sieverts' constant, and the oxygen activity was also converted to the oxygen concentration through the characteristics of the oxygen-meter cells. Hydrogen and oxygen solubilities in liquid sodium were obtained as functions of the cold-trap temperature from 115 to 208°C. Both data have a similar temperature dependence and were anomalously larger than the extrapolated values in the temperature region lower than 180°C. At 300°C, the addition of hydrogen to the liquid sodium, valved off from the purification apparatus, lowered the oxygen activity in the liquid sodium. The experimental results suggest a significant interaction between hydrogen and oxygen and the existence of (OH) species in liquid sodium. Using the solubility data of oxygen, hydrogen, and (OH) species, the free energy change of the reaction, (O)/sub in Na/ + (H)/sub in Na/ = (OH)/sub in Na/, was obtained and was ΔG°(kcal/mole) = -28 + 0.043 T. From the temperature dependence of the equilibrium hydrogen pressure, the apparent heat of a solution of hydrogen in liquid sodium was obtained as 1.6 kcal/mole.

24478 Effect of neutron irradiation on the microstructure and properties of titanium-stabilized type 316 stainless steels. Bloom, E.E.; Leitnaker, J.M.; Stiegler, J.O. (Oak Ridge National Lab., TN). *Nucl. Technol.;* **31**: No. 2, 232-243(Nov 1976).

The effects of titanium additions up to 0.6 wt percent on the irradiation-induced swelling and changes in creep-rupture properties were investigated. Samples were irradiated in the Experimental Breeder Reactor II at temperatures in the range from 450 to 700°C to a maximum neutron fluence of 7.8 x 10^{26} n/m² (<0.1 MeV). In annealed material, the irradiation-induced swelling exhibited a minimum in the range 0.2 to 0.4 wt percent titanium. The minimum in swelling was directly attributable to a minimum in the concentration of voids. Samples irradiated in the 20 percent cold-worked condition exhibited slight densification at 3.0 x 10^{26} n/m² (<0.1 MeV) at both 500 and 600°C. A small density decrease (0.23 percent) occurred during irradiation to 6.6 x 10^{26} n/m² (<0.1 MeV). Postirradiation creep-rupture ductility was a maximum for alloys containing 0.23 and 0.33 wt percent titanium. The observed swelling behavior in the annealed material is thought to be associated with changing amounts of titanium and carbon in solution in the austenite as the total titanium concentration is increased. The improved ductility is attributable to a decreased tendency for grain boundary crack formation and appears to be associated with removal of sulfur and possibly other impurities from solution in the austenite.

REGULATION AND LICENSING

24479 (RDT-INDEX—(1-21-77)) **Index of RDT standards.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Reactor Development and Demonstration). Jan 1977. Contract W-7405-ENG-26. 36p. RSO.

The index is the current listing of 285 RDT Standards issued through December 31, 1976.

24480 (REG/G—1.124(11-76)) **Design limits and loading combinations for class 1 linear-type component supports.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Standards Development). Nov 1976. 6p. Nuclear Regulatory Commission, Washington, DC.

The guide delineates acceptable design limits and appropriate combinations of loadings associated with normal operation, postulated accidents, and specified seismic events for the design of Class 1 linear-type component supports as defined in Subsection NF of Section III of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. The guide applies to light-water-cooled reactors.

24481 Nuclear hazard. Suppl. May 1975. Hebert, J. (Electricite de France, 75 - Paris. Div. du Droit Nucleaire). pp 1-44 of In Jurisclasseur. Vol. 4. Civil liability and insurance. Paris, France; Editions techniques ([nd]). (In French)

The special third party liability regime for nuclear damage is based on several international Conventions, in particular the 1960 Paris Convention and the 1963 Brussels Supplementary Convention, as well as on a number of directives adopted by the competent international organizations, namely NEA and IAEA. This regime is characterized by the absolute and exclusive liability of the nuclear operator, compensated by limitation in time and in amount, and by uniquity of jurisdiction. The French Act of 30 October 1968 is in conformity with these general principles.

24482 Nuclear pressure vessel analysis according to French regulations. de Torquat, C.; Roche, R. (Direction de la Technologie de l'Environment Industrial et des Mines, Paris, France). pp v.3 p.G1/2 1-10 of In Structural mechanics in reactor technology. Jaeger, T.A. (comp.) (Bundesanstalt fuer Materialpruefung, Berlin (Germany, F.R.)). Amsterdam, The Netherlands; North-Holland Publishing Co. (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

In nuclear power reactors, the thermal energy produced in the fuel is transfered outside the core by a fluid pressure. The envelope containing this fluid, or primary circuit, is a pressure system subject to regulations. The regulations designed for conventional pressure vessels are not well suited for nuclear vessels and 'special measures' concerning them have been worked out within the regulations. These measures are covered by the Order of February 26th 1974 extending the application of boiler and pressure vessel regulations to the nuclear reactor primary system. The main provisions of this text are emphasized: components concerned, manufacture and user responsibilities, choice of materials, quality program, files to be submitted to the authorities. The rules concerning structural analysis of nuclear vessels are examined more in detail. Loading conditions are classified under four different categories. The resistance of vessels must be estimated with special reference to the following damages: excessive distortion; plastic instability; elasto-plastic instability; progressive distortion (ratcheting); low cycle fatigue. In view of these requirements the available means of analysis are examined briefly: model tests, limit analysis, plastic finite elements methods, construction code rules, etc.

24483 Nuclear indemnity legislation in the United States. Shapar, H.K. (Nuclear Regulatory Commission, Washington, D.C. (USA)). *Nucl. Law Bull.;* No. 15, 50-72(Apr 1975). (In English and French).

From International conference on nuclear insurance and indemnity; London, UK (10 Sep 1974).

The United States legislation on the third party liability of operators of nuclear installations is contained in the Atomic Energy Act of 1954 and is generally known as the Price-Anderson Amendment. This amendment is due to expire on 1 August 1977. Therefore the Federal authorities have submitted to Congress a Bill containing new provisions on third party liability which take account of nuclear

developments during these past years. The new system proposed retains the main features of the present provisions while providing for gradual phasing out of Government indemnity to be replaced by contributions from the nuclear industry; it also plans extension of financial protection to certain nuclear incidents occurring outside US territorial limits. The present limitation of liability for nuclear damage ($ 560 million) will be raised progressively as additional private funds are available. After being considered and adopted by Congress, the Bill was vetoed by the President on constitutional grounds. It must therefore be submitted again to Congress after it is revised.

24484 Special problems concerning turnkey contracts as seen by the constructor of nuclear power plants. Groh, J. (Kraftwerk Union A.G., Offenbach (F.R. Germany)). pp 192-204 of In Nuclear Inter Jura 75 Proceedings. Paris; International Nuclear Law Association (1976). (In German)

From Nuclear Inter Jura 75 Congress; Aix-en-Provence, France (29 Sep 1975).

Turnkey contracts for the supply of nuclear installations raise a number of practical and legal problems which should be eliminated to facilitate their conclusion. This concerns, for example, the compatibility between the requirements laid down by the national legislation of the supplier and of the buyer regarding the licensing of nuclear installations. Another source of difficulty stems from the inclusion of force majeure clauses in favor of the supplier of nuclear equipment.

24485 Connections or conflicts between nuclear regulations and other regulations. Shapar, H.K. (Nuclear Regulatory Commission, Washington, D.C. (USA)). pp 20-27 of In Nuclear inter Jura 75 Proceedings. Paris; International Nuclear Law Association (1976).

From Nuclear Inter Jura 75 Congress; Aix-en-Provence, France (29 Sep 1975).

The potential for conflicts between nuclear and other regulations stems in large part from overlapping jurisdictional lines which reflect not only the basic governmental structure but the political realities as well. A completely logical pattern - with a clear differentiation of responsibilities assigned to the various departments and agencies involved - is assuredly a worthy goal, but one not often, if ever, achieved. Fortunately, innovative means for obviating or mitigating the conflicts can be and have been found.

24486 Offshore nuclear installations. Albano, R. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). pp 99-118 of In Nuclear Inter Jura Proceedings. Paris; International Nuclear Law Association (1976). (In French)

From Nuclear Inter Jura 75 Congress; Aix-en-Provence, France (29 Sep 1975).

It is possible now to foresee the creation of nuclear power plants on floating or fixed islands although from the safety viewpoint, floating islands are preferable. The definition of the legal nature of artificial islands raises a first problem insofar as artificial islands are neither islands nor ships. Furthermore, their statute would differ according to whether they were sited in territorial seas or in the new 'economic zones'. This leads to consideration of the applicability of Italian maritime legislation to nuclear power plants on floating islands without setting aside that of international regulations on radioactive maritime pollution.

24487 Siting of nuclear power plants on artificial islands: the Belgian situation. Gol, J.G. (Belgium). pp 147-165 of In Nuclear Inter Jura 75 Proceedings. Paris; International Nuclear Law Association (1976). (In French)

From Nuclear Inter Jura 75 Congress; Aix-en-Provence, France (29 Sep 1975).

The building of nuclear stations on the national territory involves reticences of an ecological nature which have induced technicians to consider other siting facilities. The creation of artificial islands, in particular nuclear stations, is therefore suggested. In the present state of the law of the sea, such construction gives rise to some intricate legal problems and leads to consideration of every notion, from the territorial sea to the exclusive economic zone. Especially regarding Belgium, the problem is to know where the legal competence for these facilities will lie. After analysis, it has been estimated that regional bodies have no specific powers in this regard and that no norm with a restricted territorial scope may be applied.

24488 Construction and operation of nuclear installations in the light of public international law. Pelzer, N. (Goettingen Univ. (F.R. Germany). Inst. fuer Voelkerrecht). pp 49-64 of In Nuclear Inter Jura Proceedings. Paris; International Nuclear Law Association (1976). (In German)

From Nuclear Inter Jura 75 Congress; Aix-en-Provence, France (29 Sep 1975).

The operation of nuclear installations carries potential dangers and risks which may lead to transfrontier damage. This fact directly concerns public international law and gives rise to the question of the legality of nuclear installations. It would seem that construction and operation of nuclear installations are permissible activities under public international law, provided that the international standards of reactor safety and radiation protection have been met and that there exists an adequate system of civil liability law. This applies in principle also to nuclear power plants located near a border. In this case a mutual obligation of consultation of the States concerned may derive from the principle of good neighbourliness.

24489 Development of nuclear law during the third United Nations Conference on the Law of the Sea. von Welck, S. (Bundesministerium fuer Forschung und Technologie, Bonn (F.R. Germany)). pp 138-146 of In Nuclear Inter Jura 75 Proceedings. Paris; International Nuclear Law Association (1976). (In German)

From Nuclear Inter Jura 75 Congress; Aix-en-Provence, France (29 Sep 1975).

The Third United Nations Conference on the Law of the Sea will influence nuclear law in the following fields: construction and operation of offshore nuclear power plants, dumping of radioactive wastes in the sea, navigation of nuclear ships and maritime transport of radioactive materials. Nuclear law experts should take advantage of the situation of the present conference which may enable them influence discussions as well as the outcome of the Conference in these fields by their expertise and knowledge.

24490 Decree of 26th January 1976 amending Section 10, paragraph three of the Act of 27th October 1965, Stb. 546, governing third party liability in the field of nuclear energy. *Staatsbl. K. Ned.;* No. 35, 1(1976). (In Dutch).

Section 10 of the Act of 27th October 1965 on nuclear third party liability (published in Staatsblad No 546) provided that the operator of a nuclear installation had to maintain insurance or financial security fixed at 50 million guilders. This is in accordance with the principles of the nuclear third party liability conventions which lay down a special regime channelling liability onto the nuclear operator and further provide that such liability must be covered in the national laws to a given amount by insurance or other type of financial guarantee. This Decree of 26th January 1976 (Staatsblad 1976 No 35) now raises this amount to 100 million guilders (N.E.A.).

24491 Some aspects of the contractual application of the limited liability of suppliers convened by several international conventions. Zaldivar, E. (Argentine). pp 205-212 of In Nuclear Inter Jura 75 Proceedings. Paris; International Nuclear Law Association (1976).

From Nuclear Inter Jura 75 Congress; Aix-en-Provence, France (29 Sep 1975).

Civil liability for nuclear damage has been the subject of specific regulations by means of International Conventions and the laws of countries which may be qualified as suppliers of nuclear fuel, materials and installations. These regulations have been necessary to facilitate development of the peaceful uses of atomic energy. A second group of countries, namely those of Latin America, which are also purchasers, lack this specific legislation and have not ratified any International Convention on the subject. In those countries civil liability continues to be ruled by the classic norms of Roman Law. This difference in regimes has made for difficulties between suppliers and purchasers and could obstruct future exchanges in matters of nuclear energy between both groups of countries. It would be desirable for the competent authorities in purchasing countries to study the means of providing their countries with nuclear third party liability legislation based on the principles of the International Conventions.

24492 Consideration of the legal system required for achievement of current nuclear power plant construction programmes. Castellon Fernandez, E. (Hidroelectrica Espanola, S.A.; Forum Atomico Espanol, Madrid). pp 28-48 of In Nucler Inter Jura 75 Proceedings. Paris; International Nuclear Law Association (1976). (In Spanish)

From Nuclear Inter Jura 75 Congress; Aix-en-Provence, France (29 Sep 1975).

The extensive nuclear power plant construction programmes currently in progress in western countries require updating of the legislation in force in this field, especially as regards the following: acquisition of the sites necessary by means of a national planning programme of available sites; simplification of formalities concerning issuance of administrative licenses; revision of the principle of absolute and exclusive liability of the nuclear operator which forms the basis of the third party liability system for nuclear damage; radioactive waste management and decommissioning of nuclear plants. Furthermore, this new legislation should be harmonized between the different countries concerned.

24493 Remarks on setting up of maximum perimissible dose values in case of accidents from the point of view of the technician. Birkhofer, A. (Technische Univ. Muenchen (Germany, F.R.)). pp 239-244 of In Viertes deutsches Atomrechts-Symposium. Referate und Diskussionsberichte. Cologne; Heymanns (1976). (In German)

From 4. German symposium on nuclear law; Goettingen, Germany, F.R. (26 May 1975).

2 figs.; 3 refs.

The draft of the Radiation Protection Ordinance sect. 28(4) is to contain equivalent dose limits, which must not be exceeded in the event of accidents in and at nuclear power plants. Thus, for the first time not only accident prevention regulations are formally fixed stipulated how far the consequences of an accident may reach. In the present situation, however, it appears more reasonable to provide the licensing authorities with general values for tolerable radiation loads, but not fix such values rigidly. Instead, it should be fixed in the Radiation Protection Ordinance, at which dose values to be expected after accidents particular steps for protecting the population, such as evacuation or agricultural restrictions, should be taken.

24494 Nuclear insurance in Canada. Tyrell, J. (Canadian Nuclear Association, Toronto, Ontario. Nuclear Insurance Committee). *Nucl. Can./Can. Nucl.;* **15**: No. 4, 2(Apr 1976). (In English, French).

Many years ago, a group of insurance companies founded an organization offering nuclear insurance, called Nuclear Insurance Association of Canada. The passage of Order-in-Council P.C. 1960-555 gave Atomic Energy of Canada Ltd. the power to indemnify suppliers, contractors, etc. against liability claims. The situation has remained essentially unchanged. In 1970 Parliament passed the Nuclear Liability Act, but it has never been proclaimed. The act sets mandatory levels of nuclear insurance as high as $75 million for firms involved in nuclear activity. It is expected that agreement between the insurers and government will be reached later this year (1976), so that the act can be proclaimed.

24495 Fourth Act amending the Atomic Energy Act. *Bundesgesetzblatt, Teil I;* No. 113, 2573-2576(Sep 1976). (In German).

The act which came into force on August 31st, 1976, is repeated literally as far as the amended sections are concerned. Sections 9a (uses of radioactive remainders and disposal of radioactive wastes), 9b 'Planfeststellungsverfahren' (concentration of nuclear licensing procedures), and 23 (competence of the PTB) have been altered in particular.

24496 Alarm systems for nuclear installations. Baas, J.L. (Ministerie van Volksgezondheid en Milieuhygiene, Leidschendam (Netherlands)). *Noodzaak;* **25**: No. 6, 105-108(Sep 1976). (In Dutch).

A new law regarding nuclear accidents was recently ratified in the Netherlands. Under this law, the Department of Health and Environmental Protection can require that special alarm and regulation systems be fitted in nuclear installations. The consequences of the adoption of this law are outlined in terms of the equipment as well as the required actions of pertinent authorities.

24497 Guideline on the protection of nuclear power plants against pressure waves from chemical reactions for a lay-out concerning their strength, induced vibrations, and safety distances. *Bundesanzeiger;* **28**: No. 179, 1-3(Sep 1976). (In German).

The present guideline serves the competent licensing authority as a sufficiently conservative basis of decision for examinig the applications for stationary nuclear power plant licences with a view to their design with respect to strength and induces vibration as well as in view of safety distances for protection against external energy influences (primarily pressure waves) from chemical reactions. The annex indicates the dimensions of safety distances between nuclear power plants and the places of potential chemical explosions. The rules defined in the guideline are preliminary in so far as they will be checked again as soon as new research results give rise thereto.

ECONOMICS

24498 Strategy for power reactor development in Japan. *Nucl. Eng. Int.;* **21**: No. 249, 35-36(Oct 1976).

A brief account is given of a report on advanced power reactor development submitted to the Japanese Atomic Energy Commission by a committed of experts. The committee, has been studying the possible strategies for power reactor development through the years up to 2000.

24499 Reducing capital and operating costs through standardization. Kennedy, W.J.L.; Morse, A. (Stone and Webster Engineering Corp., Boston, Mass. (USA)). *Nucl. Eng. Int.;* **21**: No. 249, 51-53(Oct 1976).

Standard designs for the balance of plant of nuclear power stations have been developed. Among the advantages claimed are reduced costs, shorter schedules and higher availability. The use of reliability analysis to identify components and systems to which design attention should be directed, and improved maintenance procedures are of great significance.

24500 All-electric dream. Chapman, P.F. (Open Univ., Milton Keynes (UK). Energy Research Group). *J. Br. Nucl. Energy Soc.;* **15**: No. 4, 285-295(Oct 1976).

From BNES meeting; London, UK (19 May 1976).

The increase in fossil fuel costs and possible decreases in future energy demand are highly significant factors in the role of nuclear power. An attempt is made to assess the order of magnitude of these effects, making use of a number of energy studies being carried out at the Open University. The discussions are restricted to aspects of the supply and demand situation and are not concerned with political factors.

24501 Strategies for the transition from fossil to nuclear fuels. Haefele, W.; Manne, A. *Arch. Energiewirtsch.;* **30**: No. 10, 878-894(Oct 1976). (In German).

7 figs.; 6 tabs.

Measures for the transition from today's energy sources to nuclear energy are discussed. Investigated, too, are the links between the different sources of energy, economic data, and between possible technological means for the production of synthetic fuels.

24502 Thoughts on the future of nuclear energy. Maushart, R. *G-I-T (Glas- Instrum.-Tech.) Fachz. Lab.;* **20**: No. 10, 1055-1057(Oct 1976). (In German).

A critical survey of the present nuclear energy situation is presented. The weak points of this form of energy which have become apparent in the meantime should be the reason to have a cool look for alternatives.

24503 Assurance of durable nuclear industry. Fortescue, P. (General Atomic Co.). *Nucl. Eng. Int.;* **1**: No. 249, 71-75(Oct 1976).

The problem of conservation of fuel resources resulting in a need for reactor systems with more economical fuel cycles, is discussed. Breeders and advanced converters are first considered. An examination is then made of symbiotic arrangements to form a self-sufficient power-producing complex. An illustration is given of a gas breeder-HTGR combination. The ratio of HTGR to breeder thermal power is calculated for a self-sufficient combination without provision of industry expansion, and also when allowing for industry expansion. It is shown that fuel resources can be extended and become most rapidly useful by proper portions of LWRs, fast breeders, and HTGRs.

24504 Two decades of nuclear confusion. Hinton, L. *New Sci.;* **72**: No. 1024, 200-202(28 Oct 1976).

The progress of nuclear power reactor development in the UK during the past two decades is outlined. The early lead established in the construction of nuclear power plants is now lost and an impression is given that the UK lags behind other countries. The economics of the nuclear power industry are considered and the idea of abandoning reactor development in Britain and buying licences when reactors are required is explored. Reasons for this lack of success are debated.

FUEL CYCLE

REFER ALSO TO CITATION(S) 24065, 24066, 24067, 24068, 24070, 24071

PROCESS HEAT REACTORS

24505 Method for the transfer of heat in the form of chemical energy. Wentorf, R.H. Jr. (to General Electric Co.). French Patent 2,277,308/A/. 27 Jun 1975. 11p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 1 Jul 1974, US.

The different steps of the method are described. A first gas-mixture containing mainly methane and carbon dioxide is caused to react in the vicinity of the heat-source at a temperature above 650°C, so as to obtain a second gas mixture containing mainly carbon monoxide and hydrogen. This second gas-mixture is cooled down to a temperature below 40°C. Same mixture is then compressed and transferred via a first duct up to the energy consuming area. It is then heated and caused to react in the presence of steam and a catalyst, at a temperature of at least 350°C and a pressure of at least 10 atmospheres so as to release heat to obtain mainly methane and carbon dioxide. The resulting mixture containing methane, carbon dioxide, and steam, is cooled down to under the condensation point of steam. Water and the above generated by-products are separated from the mixture containing methane, carbon dioxide, and steam, so as to form the first gas mixture. Said first gas mixture is driven via a second duct up to the heat-source, heated, and the above steps are resumed sequentially. The method can be applied to the transfer of power provided by nuclear power stations.

24506 Nuclear power plant with closed gas loop for the generation of process heat. Baumgaertner, H. (to Hochtemperatur-Reaktorbau G.m.b.H.). German(FRG) Patent 2,411,039/A/. 18 Sep 1975. 21p. (In German).

4 figs.

The nuclear power plant described has a gas cooling circuit fully integrated in a prestressed-concrete vessel, the energy of which is received by the cooling gas, passed to a secondary circuit and used for generating process heat. The high outlet temperature of the

cooling gas (< 850°C) requires a special arrangement of all components and gas lines. The gas cooling circuit (primary circuit) is subdivided into several identical lines, which include a downstream connection of a heat exchanger subdivided into a high-temperature portion and a low-temperature portion, of a blower and of gas-feeding lines. All components are disconnectably mounted in vertical shafts symmetrically enclosing the high-temperature reactor. Each component may be disconnected separately. The high-temperature and low-temperature portions of each heat exchanger unit are arranged in separate shafts; the blowers are located immediately below the low-temperature portions. Return of the relatively cold gases from the blowers involves that said gases are passed around the structural parts subject to high temperature in the form of a so-called jacket type flow. The respective secondary circuits connect the separate primary circuit lines with process and vapour turbines arranged outside the prestressed-concrete vessel and a safety vessel enclosing the latter.

NUCLEAR REACTOR TECHNOLOGY

24507 Computer assisted learning in nuclear engineering. Dodd, B. (Royal Naval Coll., Greenwich (UK)). *J. Inst. Nucl. Eng.;* **17**: No. 5, 117-119(Sep 1976).

A general discussion of what is termed computer assisted learning is first given. This is followed by an account of the work of the National Development Programme in Computer Assisted Learning (NDPCAL) set up in 1973. This includes the use of a PDP 11/40 computer, and nuclear engineering at present has the largest number of teaching programs, a list of which is given.

THEORY AND CALCULATION

REFER ALSO TO CITATION(S) 25588

24508 (HEDL-SA—1148) **Review of microscopic integral cross section data in fundamental reactor dosimetry benchmark neutron fields.** Fabry, A.; McElroy, W.N.; Kellogg, L.S.; Lippincott, E.P.; Grundl, J.A.; Gilliam, D.M.; Hansen, G.E. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Oct 1976. Contract EY-76-C-14-2170. 33p. (CONF-761127—5). Dep. NTIS $4.00.

From 5. IAEA PNE technical meeting; Vienna, Austria (Nov 1976).

The paper is intended to review and critically discuss microscopic integral cross section measurement and calculation data for fundamental reactor dosimetry benchmark neutron fields. Specifically the review covers the following fundamental benchmarks: (1) the spontaneous californium-252 fission neutron spectrum standard field; (2) the thermal-neutron induced uranium-235 fission neutron spectrum standard field; (3) the (secondary) intermediate-energy standard neutron field at the center of the Mol-ΣΣ, NISUS, and ITN—ΣΣ facilities; (4) the reference neutron field at the center of the Coupled Fast Reactor Measurement Facility (CFRMF); (5) the reference neutron field at the center of the 10 percent enriched uranium metal, cylindrical, fast critical; and (6) the (primary) Intermediate-Energy Standard Neutron Field.

24509 Entrapping of gas from the free surface of a flow under conditions of flow around a system of cylinders. Borovkov, V.S.; Mayranovskii, F.G.; Chechelnitskii, M.S.; Gorbachev, S.I. pp 305-320 of In Ecoulements diphasiques et cavitation dans les systemes de production d'energie. Paris; Societe Hydrotechnique de France (1976).

From Symposium on two phase flow and cavitation in power generation systems; Grenoble, France (30 Mar 1976).

Reactor cooling circuits.

Studies enabled establishment of the mechanism of gas entrapping from the flow free surface under the conditions of flow around a system of cylinders. The data obtained offer a means to forecast conditions under which the process of gas entrapping may occur. Factors controlling the depth of gas bubble penetration into the flow of liquid, dimensions of originating gas occlusions and de-aeration length are discussed.

24510 Adjoint in reactor theory. Greenspan, E. (Ben-Gurion Univ. of the Negev, Beersheba (Israel). Dept. of Nuclear Engineering). *Ann. Nucl. Energy;* **3**: No. 5;6, 323-327(1976).

A generalized total importance balance condition is presented for time-dependent problems with delayed neutron precursors. It is shown that this condition provides a unified formulation that is useful for deducing (1) the equations, boundary conditions, and time conditions satisfied by adjoint functions of different physical meaning; and (2) the mathematical foundation for different applications of adjoint functions (author).

24511 Comments on 'a note on the adjoint function in time dependent reactor theory'. Greenspan, E. (Ben-Gurion Univ. of the Negev, Beersheba (Israel). Dept. of Nuclear Engineering). *Ann. Nucl. Energy;* **3**: No. 5;6, 329-330(1976).

A reply is given to a recent proposal by Ronen that applying adjoint functions for the calculation of the time integrated neutron density at a given point results in reduction of computational effort: i.e. instead of solving the time dependent transport equation, it is sufficient to solve one adjoint and one forward steady-state equation. It is shown that it is possible to calculate the same time-integrated density from the solution of two steady state forward equations. It is also shown that Ronen's formulation is a special case of a total importance balance condition.

24512 Toward a unified theory of reactor neutron noise analysis techniques. Pacilio, N.; Jorio, V.M.; Norelli, F.; Mosiello, R.; Colombino, A.; Zingoni, E. *Ann. Nucl. Energy;* **3**: No. 5-6, 239-251(1976).

A theory is first presented for describing reactor neutron noise as a stochastic process with neutrons and neutron counts from a multi-detector measuring apparatus as state variables. The reactor system is completely characterized in the time evolution of mean values and fluctuations of its state variables by a multivariate joint distribution. The same theoretical achievement is then mainly oriented to expressing mathematical formulae for the interpretation of experimental results. The experimental evidence deals with neutron counts only: therefore the generating function to be used is that related to the univariate or bivariate marginal distributions of neutron counts. These functions are shown to generate all the neutron noise analysis techniques developed by a three-decade experience in nuclear reactor experimental physics. An energy and space-independent reactor model is considered in each case.

24513 Calculation of weakly-interacting systems. Ginkin, V.P. *At. Energ. (USSR);* **40**: No. 1, 57-58(Jan 1976). (In Russian).

Deposited article; for English translation see the journal Sov. J. At. Energy.

24514 Suboptimal control of point reactors by using singular perturbation theory. Asatani, K. (Musashino Electrical Communication Lab., Tokyo (Japan)); Shiotani, M.; Hattori, Y. *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 1, 1-8(Jan 1976).

A systematic method is presented which synthesizes suboptimal control in the regulator problem occasioned upon the deviation of a point reactor from equilibrium. The method is based on the singular perturbation theory with advantage taken of the small ratio existing between the mean life time of the prompt neutron and the total delayed-neutron fraction. The idea of time separation is applied to the boundary layers at both ends of the control period, which yields a uniformly valid solution in the form of an asymptotic series for the control and for the neutron density trajectory. The limits of error are given for the series solution thus derived. The method is shown to bring about considerable reductions in the demands on both computer time and memory through elimination of the stiffness inherent in the original system. Some numerical examples are presented to demonstrate the validity of the proposed method. A similar formulation can be applied also to the problem of control during a change of power level, when considered as a tracking problem.

24515 Reactor noise theory based on system size expansion. Kishida, K.; Kanemoto, S.; Sekiya, T. (Osaka Univ., Suita (Japan). Faculty of Engineering). *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 1, 19-29(Jan 1976).

When a reactor noise theory is applied to reactor diagnosis or stability analysis, it is necessary to consider non-linear non-stationary reactor noise phenomena. A new approach to the reactor noise theory is developed on the basis of recent studies on the theory of non-linear non-equilibrium statistical physics. This approach brings into relief the importance of making a clear distinction between extensive and intensive variables. A basic equation is derived in a quite general form, which yields a solution of asymptotic character for large systems. In the lowest-order approximation, the formalism yields the conventional equations. This leads to a clear description of the relation between the Langevin and the Kolmogorov methods, and substantiates the assumption of Gaussian distribution of the number of neutrons. A rigorous analysis of the newly derived equation is made with the aid of flow patterns representing the Hamilton-Jacobi equation. A sample application of the formalism is presented for a system with randomly fluctuating parameters.

24516 Method of thermodynamic analysis of the thermal diagram of a nuclear power plant in different conditions of operation by means of a computer. Gokhshtein, D.P.; Kirov, V.S.; Fedorov, O.M.; Sedov, V.K.; Golubev, L.I. (Odessa Polytech Inst, Ukr SSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 6, 54-58(Jun 1976). (In Russian).

A method of thermodynamic analysis of thermal diagrams of nuclear power plants, relying on the entropy method, is set forth. A description is given of a computer-aided program of calculation of the thermal efficiency of the 3rd block of the Novovoronezhskaya

nuclear power plant. Using a separately taken element of the thermal diagram, the sequence of operation of this program is demonstrated.

24517 Optimization of burnup. Berger, J. (Ingenieurhochschule Zittau (German Democratic Republic). Sektion Kraftwerksanlagenbau und Energieumwandlung). *Kernenergie;* 9: No. 8, 233-236(Aug 1976). (In German).

A review is given of modern methods for optimizing the fuel cycle. In particular, problems of optimizing the burnup and control operations are dealt with. Representative work in this field is presented.

24518 Use of polarity correlation in nuclear reactor studies. Athanassopoulos, A. (Manchester Univ. (UK). Simon Engineering Labs.). *J. Inst. Nucl. Eng.;* 17: No. 5, 122-125(Sep 1976).

The advantages of employing noise techniques to the analysis of nuclear reactor matters are first summarised. This is followed by consideration of the special technique known as polarity correlation. This means, in particular, statistically analysing the polarities of the sampled values of a signal (Gaussian) with respect to its mean value, instead of analysing the corresponding full amplitude values and implies one-bit quantisation of the signal involved. The polarity analysis method is described with reference to application in the time domain and the frequency domain. Some experimental work with the URR PYE-AMF research reactor is described using a Honeywell DDP-516 8R minicomputer coupled to a Microconsultants Analog-to-Digital Converter, and details are given of the experimental procedure, which allowed calculation of decay constants, reactivity, coupling coefficients, absolute power, etc. Advantages of the technique for application in the time or frequency domain are stated.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 24375, 24761, 24805, 24809, 24810, 24811, 24812, 24814, 24815, 24816, 24817, 24852, 25008, 25060

24519 (BMI-NUREG—1958) **Residual stresses at girth-butt welds in pipes and pressure vessels. Quarterly progress report, July 15, 1976—October 15, 1976.** Rybicki, E.F. (Battelle Columbus Labs., Ohio (USA)). Oct 1976. 51p. Dep. NTIS $4.50.

A progress summary is presented for a combined experimental and analytical study to develop mathematical models for predicting residual stresses in girth-butt welds. The program is divided into three tasks, a critical literature review, laboratory tests, and development of analytical models. The literature review has been completed. Specific analytical models for predicting temperature distributions and residual stresses have been identified. Preliminary calculations with the temperature model showed good correlation with experimental data. The mathematical representation for predicting stress distributions in welded joints is in early stages of development. The model recognizes individual weld passes, distortions, and stresses due to each weld pass, temperature dependent material properties, elastic-plastic stress-strain behavior, and elastic stress-strain unloading from an elastic-plastic state of stress. Preliminary checks on the stress analysis model successfully demonstrated its capability to handle unloading. The first welding experiment has been completed. Data are still being obtained from the specimens. Residual strains are obtained by placing gages on the pipe after the test. The gages are cut out and the change in strain is recorded. This strain is attributed to the residual stress in the material. Foil strain gages placed on the pipe prior to welding did not survive the high temperature environment. Plans for future experiments are to use a special high temperature strain gage at selected locations to obtain some information about the strain history during welding.

24520 (BMI-NUREG—1959) **Critical experiments, measurements and analyses to establish a crack arrest methodology for nuclear pressure vessel steels. Task 62. Second annual progress report, 1 July 1975 to 30 June 1976.** Hahn, G.T.; Gehlen, P.C.; Hoagland, R.G.; Marschall, C.W.; Kanninen, M.F.; Popelar, C.; Rosenfield, A.R. (Battelle Columbus Labs., Ohio (USA)). Oct 1976. vp. Dep. NTIS $6.75.

Developments of the theory, the analyses and the materials characterization for assessments of crack arrest in heavy walled nuclear pressure vessels are described. A two-dimensional, dynamic, finite difference analysis of crack propagation and arrest, including inertia forces and thermal stresses is derived. The analysis is used to treat run-arrest events in DCB- and SEN-specimens. Calculations based on the one-dimensional analysis are compared with detailed measurements of run-arrest in two polymeric materials. The agreements between calculations and experiments support the dynamic, energy conservation theory of crack arrest. Implications of a K/sub ID/-crack velocity curve with a negative slope are examined. The quantity K/sub Im/, the minimum propagating crack toughness, is identified as the crack arrest material property for engineering applications. Considerations entering the design of a crack arrest property measuring procedure, including specimen shape, size, thickness and the crack jump are discussed. The influence of side grooves on the propensity for crack branching is examined. Compliance measurements for rectangular DCB-specimens are presented and analyzed. Energy losses arising from damping remote from the crack tip in an A533B steel DCB specimen are described, and classed as negligible. Interactions between test pieces and the loading system are examined. A simplified procedure for measuring K/sub D/-, K/sub m/-, and K/sub a/-values, based on the dynamic analysis of the crack length at arrest is demonstrated. Measurements of K/sub D/ at temperatures in the range (NDT-66)C to (NDT +34)C and for crack velocities in the range 200 ms^{-1} to 1000 ms^{-1} are presented. The connection between propagating crack toughness values and the rapidly loaded stationary crack toughness K/sub Id/ is examined.

24521 (BNL—21867) **Some aspects of vibration control support design.** Bezler, P.; Curreri, J.R. (Brookhaven National Lab., Upton, N.Y. (USA)). Jun 1976. Contract EY-76-C-02-0016. 5p. (CONF-761062—5). Dep. NTIS $3.50.

From 47. shock and vibration symposium; Albuquerque, New Mexico, United States of America (USA) (19 Oct 1976).

The effectiveness and optimal placement of vibration control supports in reactor piping systems is discussed. Transfer matrix methods were used to evaluate some typical simple systems and the results are presented.

24522 (LA-NUREG—6532-M) **MOVIE.LASL version 1.0 user's manual.** Brown, B.E. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1976. Contract W-7405-ENG-36. 29p. Dep. NTIS $4.00.

MOVIE.LASL is an interactive Fortran program for display and animation both of finite-element models and of the results of their analysis. The program runs on the Los Alamos Scientific Laboratory's LTSS system. The user may manipulate the model (rotate, translate, zoom in, etc.), specify colors for the background and the different element groups, and select various display devices. Both line drawings and continuous-tone color images can be produced. Single frames or animated movie sequences are also available and can be displayed on any of the output devices.

24523 (PB—250030) **Inspection of nuclear reactor welding by acoustic emission. Final report, Phase I, November 1974—November 1975.** Prine, D.W.; Clark, R.N. (GARD, Inc., Niles, Ill. (USA)). Feb 1976. vp. (NUREG—0035-1). NTIS $5.00.

This report covers work accomplished in the first year of a three year research program sponsored by the United States Nuclear Regulatory Commission, Reactor Safety Research Division, Metallurgy and Materials Research Branch. The goal of this phase is to show feasibility and develop equipment design parameters for real time, in process, NDE of nuclear power piping welds by means of Acoustic Emission. Included in this report is some introductory material that was previously published in the first interim report, May 1975. In addition, extensive documentation of one calibration and two production tests is included. The test results definitely show that in-process NDE of nuclear power piping welds by means of Acoustic Emission is feasible and practical. Results show that Acoustic Emission is very effective at detecting cracking type flaws during the welding process and that simple digital logic in conjunction with frequency discrimination can eliminate the many interfering background noises encountered in a production environment.

24524 Technique of recuperative purification of liquid media and device therefor. Ciganek, F.; Dubsek, F.; Tomes, V.; Kugler, V. Czech Patent 150,018. 15 Aug 1973. 5p. (In Czech).

The invention claims a method of purifying liquid or liquefied media having a recuperative effect. The method may be applied to media containing impurities of a specific weight higher than that of the purified medium. Also claimed is the purification equipment using the method. The proposed method overcomes the main disadvantages of the other equipments, i.e., low efficiency, and the insufficient use of the purification equipment capacity. The adjustment of recuperative treatment plants according to the invention will significantly reduce the sedimentation level. The purified medium flows radially along the entire height of the sedimentation chamber which significantly reduces the mean flow rate. An additional series of sedimentation areas secures an even and intensive contact of crystals with the oversaturated solution in built-in sedimentation areas and significantly speeds up the crystallization process. The equipment may be employed in nuclear power (especially for liquid metal purification), in the chemical and the food industries.

24525 Elektrische Maschinen und Antriebe in thermischen Kraftwerken. (Electric machinery and drives in thermal power stations). Berlin, Germany, F.R.; VDE (1974). 501p. (In German).

From VDE experts' meeting on electric machinery and drives in thermal power stations; Muenchen, Germany, F.R. (13 May 1974).

With figs., tabs. and refs.

The following subjects were dealt with during the VDE meeting: 1) Requirements made by the electric network on the

generators and their excitation equipment, and the influence thereof on their design; 2) requirements made by the power station process on the electric drives and the influence thereof on type and design; 3) requirements made on protective measures from the point of the electric power station machinery.

24526 Mesh rosette with flexible guiding of spaced elements. Kubacek, A.; Plihal, K. Czech Patent 152,039. 15 Jan 1974. 5p. (In Czech).

Various types of mesh rosettes are used in securing the required transversal configuration and the support and in preventing the cross vibrations of a bundle of longitudinal dilatation elements of various devices, such as heat exchanger tubes or nuclear reactor fuel rods. A new type is proposed of a mesh rosette having a flexible means of supporting the spaced elements and formed by one or more spiral spacer strips attached to the common peripheral band of the rosette. The rosette has considerable rigidity, a flexible element support, low hydraulic resistance, and is easy to produce.

24527 Device for rapidly mounting and dismounting the covers of pressurized vessels in particular of nuclear reactor vessels. Meuret, P. (to Constructions Navales et Industrielles de la Mediterranee). French Patent 2,279m001/A/. 28 May 1974. 7p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

Description is given of a device for rapidly mounting and dismounting the covers of pressurized tanks in particular of reactor vessels, characterized in that it comprises one or several metal parts arranged about each of the pins fixing the cover, said parts being adapted to be heated so that a temperature rise induces, at the moment of dismounting, the expansion of each pin and the loosening of the nut.

24528 Gripping device for control elements in nuclear reactors. Jones, T.A.; Anthony, A.J. (to Combustion Engineering, Inc.). German(FRG) Patent 2,357,978/A/. 6 Jun 1974. 27p. (In German).

10 figs.

The gripping device provides grab and release elements for connecting the control rods with the drive mechanism. These elements are grab fingers lying opposite one another and working together with the coupling heat on the control rod. On the inner walls of the grab finger tips, inclined planes are formed which may rest on corresponding inclined planes on the coupling head. The lower inclined planes of the grab fingers seize behind the coupling head. The necessary handling element is a tube with a double - cone on the inner wall of its top. During downward movement of the tube relative to the grab fingers the inclined planes of the double cone exert a force on the grab fingers coaxially arranged within the tube. Then the grab fingers themselves, through their inclined planes, exert a force on the coupling heat acting in a direction inclined with respect to the longitudinal axis. The coupling head is thus kept rigid against vertical or horizontal movements.

24529 Improvements to power-generating thermodynamic methods and installations. (to Electricite de France). French Patent 2,275,643/A/. 18 Jun 1974. 20p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

The installation comprises a heat-source, e.g., a boiler, a first loop in which sulfur is circulated and comprising, after the boiler exchange-bundle, a turbine, and a condenser. A second loop, in which is circulated steam, comprises downstream the condenser, a condenser turbine and return feed pumps. This can be applied to power-stations, the heat-source of which is at a very high temperature (LMFBR type reactors, high temperature gas cooled reactors, and molten salt reactors).

24530 Method and devices for building the walls and roof of a large-size reinforced-concrete construction. (to Constructions Metalliques de Provence). French Patent 2,278,862/A/. 19 Jul 1974. 9p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France).

The present invention relates to a method for making the inner shuttering of large-size reinforced-concrete construction. In order to cast the first concrete layer of the cover dome of an enclosure comprising an inner metal envelope, the metal dome has to be propped up, which sets difficult problems. According to the invention, the enclosure is made tight and is filled with a compressed fluid, e.g. compressed air under a pressure of 0.1bar. The gas pressure counterbalances the concrete weight, thus making it possible to dispense with stays. A possible application lies in the manufacture of the concrete roof and, contingently, of the concrete vertical walls of a nuclear-reactor enclosure.

24531 Catching device for flanged nozzles in the bottom of a reactor pressure vessel and the corresponding joints. Mainka, A. (to Licentia Patent-Verwaltungs-G.m.b.H.). German(FRG) Patent 2,312,803/A/. 26 Sep 1974. 8p. (In German).

5 figs.

The catching device is to prevent the dropping-out, e.g. of a control rod, if the nozzle belonging to it breaks away from the bottom of the pressure vessel. It therefore consists of a plate arranged below the pressure vessel, and adjustable bolts for the penetration nozzles attached to the plate. The adjustable bolts themselves carry a catching flange supported by shock absorbers. Each shock absorber is composed of a strain cartridge and a shaping bush put over the adjustable bolt and held by a nut. The shaping bush may have a short sloping inlet while the strain cartridge is pressed into the bush at large axial stresses.

24532 Grabbing device of a hoisting mechanism in particular in a nuclear reactor for settling and picking up nuclear fuel elements and control elements. Fehl, A.; Hoffmeister, B. (to Krupp (Friedr.) G.m.b.H.). German(FRG) Patent 2,317,014/A/. 17 Oct 1974. 40p. (In German).

11 figs.

The grabbing device is suited for picking up and putting down fuel elements and control rods. It uses a raisable and depressable grab body which can be coupled to various handling tools, e.g. gripper latches, for one group of elements to be moved at a time. Operating of the handling tools is done by only one power apparatus, e.g. a pneumatically operated piston-cylinder-mechanism or a magnet core-coil mechanism housed within the grab body. The grab body itself is displaceable in vertical direction within the guide pole mounted on the frame of a movable charging device. These movements are executed by means of a rope winch.

24533 Shut off nozzle for liquid metals. Stoffregen, G. (to Internationale Atomreaktorbau G.m.b.H. (INTERATOM)). German(FRG) Patent 2,326,498/A/. 5 Dec 1974. 7p. (In German).

2 figs.

The isolating valve is used in pipes carrying liquid metal - especially sodium. It can be sealed completely by freezing small amounts of liquid metal. The casing of the valve is connected with nozzles. Within the casing rotable plug is mounted on a footstep of stellite. Between the casing and the plug there is a gap of about 1 mm. Through the hollow plug, a penetration is running. The plug can be rotated by means of a spindle led out of the casing. A cooling or heating liquid is fed through a channel in the spindle to the interspace beetween the penetration and the wall of the plug. As heating or cooling liquid, hot or cold nitrogen is used. With it, the liquid metal in the gap between plug and case may be frozen or melted. The backflow of the liquid takes place in the interspace between channel and inner wall of the spindle.

24534 Hybrid annular sector elements for flexural analysis of perforated plates with or without tube stiffeners. Ramesh, C.K.; Jayaram, S. (Indian Inst. of Tech., Bombay). pp 13p, Paper F7/9 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

This paper is concerned with the finite element analysis of plates having a large number of perforations which are either free or stiffened by tube elements. These plates are subjected to both temperature and pressure loadings and are of common occurrence in nuclear reactor vessels.

24535 Analysis of locally reinforced holes and transition regions in thin walled structural members. Widera, G.E.O.; Amon, R. (Illinois Univ., Chicago (USA)); Kitz, G.T. (Sargent and Lundy, Chicago, Ill. (USA)); Doyle, J.M. (Bert B. Hanson and Associates, West Union, Iowa, USA). pp 12p, Paper F7/8 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Solutions useful for the determination of the state of stress and stability in panels, plates and shells possessing both reinforced and unreinforced holes are presented. Also discussed are problems involving the local reinforcement of mating structural elements. Depending on the problem either plane stress elasticity or plate and shell theory is employed for the structural member. The reinforcement is treated as a beam having tensile, torsional and flexural stiffnesses. A restriction on the reinforcement is that the width of the beam is small compared to the radius of the hole, plate or shell. In the case of a panel, it is furthermore assumed that the hole is small compared to the depth of the panel and that the distance of the hole's center to an edge is large compared to the radius of the hole.

24536 Application of acoustic emission measurements on laboratory testpieces to large scale pressure vessel monitoring. Ingham, T.; Dawson, D.G. (UKAEA Reactor Group, Risley). pp 14p, Paper G3/8 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The paper outlines briefly the development of laboratory acoustic emission testing at REML and describes the results of recent tests using a laboratory facility capable of emission location. These tests were done in conjunction with a full scale pressure vessel experiment and acoustic emission data from small scale and large scale tests are presented and discussed.

24537 Holographic interferometry and laser speckle photography as aids to assessment of pressurized components. Martin, D.J.V. (UKAEA Safety and Reliability Directorate, Culcheth). pp 9p, Paper G3/10 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

This paper gives details of the defect detection holographic technique and describes laser speckle photography to evaluate in phase movement and strain in pressurized components. The new fibre optic technique and system appraisal is included. The holographic tests show that it is possible to detect on the outside of tubes defects in the bore approximately 10% of thickness deep. Speckle photography gives object lateral movement, direction and strain.

24538 Assessment of acoustic emission techniques on medium-sized pressure vessels tested to failure. Sinclair, A.C.E.; Formby, C.L.; Connors, D.C. (UKAEA Reactor Group, Risley). pp 16p, Paper G3/9 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Location analysis has been used to examine acoustic emission from a partial thickness slit in a test vessel during pressurization. Preliminary invesigations showed that sharp emission pulses at a source would propagate as sharp pulses to a sensor several metres distant and that intrinsic material attenuation was negligible at the 165 kHz operating frequency. Pulse arrival times at three sensors were used to locate emission sources and the requirement for near-coincidence in arrival time at all sensors reduced background noise to very low levels. The slit was clearly delineated by its emission. Emission activity moved from the centre to the ends of the slit as the stress on the slit increased, suggesting that emissions were generated during the initial yielding of the steel. This indication was strengthened by the fact that the emission count appeared to be directly proportional to the volume of plastically yielded material associated with the defect, based on a simple model for the increase in plastic zone size with pressure. Application of acoustic emission techniques to structural validation is discussed in terms of the measured amplitude spectrum of the detected acoustic emissions. A relationship is derived between the detected emission count, the threshold amplitude for detection, the sensor spacing and the created plastic volume for the steel studied.

24539 Flaw identification using acoustic emission. Woodward, B.; McDonald, N.R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights. Engineering Research Div.). pp 12p, Paper G3/7 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Acoustic emission 'signatures' contain information about the fine structure of metallurgical source events and their interpretation may provide a means of assessing the severity of internal flaws as well as surface flaws. The ultimate aim of this research on signature analysis is to develop a real time non-destructive testing technique having the capability of flaw recognition as well as flaw location in nuclear reactor components and structures under stress. Thus the requisite, unlike that in most acoustic emission work to date, is for a technique which affords discrimination between acoustic emission from different types of flaws propagating simultaneously. The approach described here requires detailed analysis of the emission signatures in terms of a specific statistical parameter, energy spectral density. In order to realise the full inspection potential of acoustic emission monitoring data obtained from zirconium and steel test-pieces have been correlated with metallurgical condition and mechanical behaviour, since the nature of emission signatures is strongly affected by the physical characteristics and internal structure of the material.

24540 Unified concepts of constitutive modelling and numerical solution methods for concrete creep problems. Argyris, J.H.; Szimmat, J.; Willam, K.J. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Statik und Dynamik der Luft- und Raumfahrtkonstruktionen); Pister, K.S. (California Univ., Berkeley (USA)). pp vp, Paper H2/1 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24541 Large-deflection elastic buckling pressures of very thin torispherical and ellipsoidal shells subjected to uniform internal pressure. Aylward, R.W.; Galletly, G.D.; Mistry, J. (Liverpool Univ. (UK). Dept. of Mechanical Engineering). pp 9p, Paper G2/4 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Very thin torispherical or ellipsoidal shells subjected to internal pressure are used in various industries and one possible mode of failure is circumferential buckling, involving a large number of waves, or lobes, around the circumference. It is, of course, essential to check that this failure mode does not occur in practice. For very thin shells, this means that non-linear large-deflection shell theory has to be used to calculate the elastic bucking pressures; such computations are often time-consuming and expensive, since a search for the minimum buckling pressure has to be made over many circumferential wave numbers. Incorrect buckling estimates may be obtained if the search is not made carefully or if a poor circumferential wave number is used as the initial choice. In the paper, the results of limited parametric survey on internal pressure buckling of constant-thickness shells are presented which, it is hoped, will aid designers of such structures. The minimum elastic buckling pressures were determined using the variational finite-difference program BOSOR 4 and they were cross-checked using the finite element program MIST 1.

24542 Reidual stresses in weld-clad reactor pressure vessel steel. Bertram, W. (Allgemeine Elektricitaets-Gesellschaft AEG Telefunken, Frankfurt am Main (Germany, F.R.)). pp 13p, Paper G1/9 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975). (In German)

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Cladding of low alloy nuclear reactor pressure vessel steel with austenitic stainless steel introduces in heavy section components high residual stresses which may cause microrack formation in stress relief heat treatment. In this investigation an attempt is made to contribute to the solution of the stress relief cracking problem by determining quantitatively the magnitude and distribution of the residual stresses after cladding and after subsequent stress relief heat treatment. Lower residual stresses are caused by reduced thickness of the components. As the heat input is decreased at identical base material thickness, the residual stresses are lowered also. The height of the tensile residual stress peak, however, remains approximately constant. In stress relief annealed condition the residual stresses in the cladding are in tension; in the base material the residual stresses are negligibly small.

24543 Limit analysis of cylinder-cylinder intersections to internal pressure. Biron, A.; Courchesne, A. (Ecole Polytechnique, Montreal, Quebec (Canada)). pp vp, Paper G1/8 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24544 Refined analysis of piping systems according to nuclear standard regulations. Bisconti, N.; Lazzeri, L.; Strona, P.P. (Societa Italiana Impianti, Genoa). pp 12p, Paper F3/3 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The problem of analyzing a piping line to nuclear standard regulations has been widely discussed in the open literature. The following problems are discussed: a) to analyze the piping under various loading conditions both static (dead weight, thermal movements etc.) and dynamic (seismic, steam hammer etc.); b) to analyze the piping from the regulatory point of view to show its acceptability and conformance to the applicable rules (generally ASME 3); c) to handle a very large amount of data and to transfer them from one program to another; d) to compute some data necessary for the analysis from the ones available in the specifications (e.g. to convert data on thermal transitories into transitories on the pipe wall or to compute floor response spectra from data on seismic analysis of applicable buildings floors); e) to check for possible errors mainly in the description of the geometry. These problems belong to different fields (structural, seismic, thermal, computer programming) and their solution requires a combination of efforts of people with different experience.

24545 Minimum weight design of prestressed concrete reactor pressure vessels. Boes, R. (Technische Univ. Berlin (Germany, F.R.).

Inst. fuer Allgemeine Bauingenieurmethoden). pp 9p, Paper H2/8 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975). (In German)

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

A method of non-linear programming for the minimization of the volume of rotationally symmetric prestressed concrete reactor pressure vessels is presented. It is assumed that the inner shape, the loads and the degree of prestressing are prescribed, whereas the outer shape is to be detemined. Prestressing includes rotational and vertical tension. The objective function minimizes the weight of the PCRV. The constrained minimization problem is converted into an unconstrained problem by the addition of interior penalty functions to the objective function. The minimum is determined by the variable metric method (Davidson-Fletcher-Powell), using both values and derivatives of the modified objective function. The one-dimensional search is approximated by a method of Kund. Optimization variables are scaled. The method is applied to a pressure vessel like for THTR. It is found that the thickness of the cylindrical wall may be reduced considerably for the load cases considered in the optimization. The thickness of the cover is reduced slightly. The largest reduction in wall thickness occurs at the junction of wall and cover.

24546 Forced vibrations of a shell inside of a narrow water annulus. Bowers, G.; Horvay, G. (Massachusetts Univ., Amherst (USA)). pp 12p, Paper F2/8 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The response of a shell to pulsating pressure in a narrow water filled annulus is determined. The analysis is patterned after L.E.Penzes according to which the imposed pump pressure over a portion Δx,Δtheta of the outer periphery (at radius b) is replaced by an equivalent radial body force of amplitude Q acting over an appropriate radial thickness Δ. The study is aimed at incorporating, in the forced vibration analysis of reactor core support baskets, the effect of entrained water mass.

24547 Computation of stress intensity factors for nozzle corner cracks by various finite element procedures. Broekhoven, M.J.G. (Delft Univ. of Technology (Netherlands). Lab. for Thermal Power and Nuclear Engineering). pp 12p, Paper G4/6 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Application of linear elastic fracture mechanics, requiring the determination of crack tip stress intensity factors (K-factors), is recommended in the ASME pressure vessel code (Section III, 1974 edition, Appendix G) for protection against non-ductile failure of nuclear pressure vessels. Due to the high local stresses associated with nozzle-to-cylinder junctions these areas deserve special concern in a fracture safety analysis. The complexity of both geometry and stress distribution at nozzle junctions seems to exclude the derivation of exact analytical solutions for K-factors and to indicate the application of the finite element technique as the prime approach for obtaining values. The present study aims at deriving accurate K-factors for a series of 5 elliptical nozzle corner tracks of increasing size by various finite element procedures, using a three-level recursive substructuring scheme to perform the computations in an economic way on an intermediate size computer (IBM 360/65 system). A nozzle on a flat plate has been selected for subsequent experimental verification, this configuration being considered an adequate simulation of a nozzle on a shadow shell.

24548 Free vibration of finite cylindrical shells by the variational method. van Campen, D.H.; Huetink, J. (Technische Hogeschool Twente, Enschede (Netherlands)). pp 13p, Paper F8/4 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The calculation of the free vibrations of circular cylindrical shells of finite length has been of engineer's interest for a long time. The motive for the present calculations originates from a particular type of construction at the inlet of a sodium heated superheater with helix heating bundle for SNR-Kalkar. The variational analysis is based on a modified energy functional for cylindrical shells, proposed by Koiter and resulting in Morley's equilibrium equations. As usual, the dispacement amplitude is assumed to be distributed harmonically in the circumferential direction of the shell. Following the method of Gontkevich, the dependence between the displacements of the shell middle surface and the axial shell co-ordinate is expressed approximately by a set of eigenfunctions of a free vibrating beam satisfying the desired boundary conditions. Substitution of this displacement expression into the virtual work equation for the complete shell leads to a characteristic equation determining the natural frequencies. The calculations are carried out for a clamped-clamped and a clamped-free cylinder. A comparison is given between the above numerical results and experimental and theoretical results from literature. In addition, the influence of surrounding fluid mass on the above frequencies is analysed for a clamped-clamped shell. The solution for the velocity potential used in this case differs from the solutions used in literature until now in that not only travelling waves in the axial direction are considered.

24549 Simplified dynamic analysis for reactor piping systems under blowdown conditions. Chen, M.M. (Boston Univ., Mass. (USA)). pp 10p, Paper F5/1 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

In the design of pipelines in a nuclear power plant for blowdown conditions, it is customary to conduct the dynamic analysis of the piping system to obtain the responses and the resulting stresses. The calculations are generally repeated for each design modification either in piping geometry or in its supporting system until the design code is met. The numerical calculations are, in general, very costly and time consuming. There has been no simple means for calculating the dynamic responses for the design. The proposed method is aimed for this purpose. The basic procedure, which is based on small perturbation theory, greatly simplifies the calculation. The procedure can be used to determine the incremental response due to a structural modification and to determine the required structural changes as a result of specified changes of dynamic response. The method can be beneficially used in the preliminary design.

24550 Vibrations of a group of circular cylindrical structures in a liquid. Chen, S.S. (Argonne National Lab., Ill. (USA)). pp 11p, Paper D2/7 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Presented in this paper are (1) a brief review of coupled vibrations of multiple structures submerged in a liquid; (2) a method of analysis for free and forced vibrations of a group of cylinders in liquid; (3) cross-flow vibrations of tube-rows; and (4) parallel-flow-induced vibrations of rod bundles.

24551 Simulation of void-crack interaction by a finite element fracture mechanics technique. Chopra, P.S.; Johnson, D.L. (Argonne National Lab., Ill. (USA)); Hartz, B.J. (Washington Univ., Seattle (USA)). pp 11p, Paper C4/4 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Most commonly employed metals are polycrystalline and, as such, are neither homogeneous nor isotropic at the sub-macroscopic level. In an earlier paper, Hartz and Chopra presented a technique for investigation of multiple fracture of such a material. This work is now expanded in an attempt to analytically treat different secondary crack or imperfection configurations and interpret these configurations in terms of actually occurring metallurgical phenomena. The latter include grain boundaries, dislocations (loops, lines, and networks) and large porosity. Further refinement of this technique is expected to provide a method for analyzing secondary cracks represented by sub-microscopic inhomogeneities such as the voids formed in stainless steel during fast neutron irradiation.

24552 Experimental study on the effect of repeated variable loads on steel piping components. Citti, P. (Florence Univ. (Italy)); Del Puglia, A.; Nerli, G. (Pisa Univ. (Italy)). pp 13p, Paper F3/8 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The main problem which occurs in the calculation of the progressively increasing deflections, typical of incremental collapse phenomena of beams subjected to variable repeated loads, is the assumed material behaviour. The incremental collapse problem is present in piping components, when, during emergency conditions, many overload cycles which exceed elastic limits are possible. The scope of the present work is to find out how to consider material behaviour in the calculation; since the calculation should present as little difficulties as possible, while in the meantime it is necessary to obtain sufficiently accurate and technically meaningful results. In this paper piping components of plain carbon and of stainless steel, subjected to variable repeated loads, are considered.

24553 Nonlinear analysis of prestressed concrete reactor pressure vessels. Connor, J.J. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Civil Engineering); Sarne, Y. (Stone and Webster

Engineering Corp., Boston, Mass. (USA)). pp 10p, Paper H2/2 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Numerical procedures for predicting the nonlinear behaviour of a prestressed concrete reactor vessel over its design life are discussed. The numerical models are constructed by combining three-dimensional isoparametric finite elements which simulate the concrete, thin shell elements which simulate steel liner plates and layers of reinforcement steel, and axial elements for discrete prestressing cables. Nonlinearity under compressive stress, multi-dimensional cracking, shrinkage, and stress/temperature induced creep of concrete are considered in addition to the elastic plastic behaviour of the liner and reinforcing steel. The analysis of an actual PCRV is described. Stress contours and cracking patterns in the region of cutouts corresponding to operational pressure and temperature loads are illustrated. The effects of creep, unloading,and creep recovery are then shown. Lastly, a strategy for assessing the performance over its design life is discussed.

24554 FAUN: a general program for the elastic analysis of frames, pipeworks and shells. Enderby, J.A.; Knowles, J.A. (UKAEA Reactor Group, Risley). pp 10p, Paper F6/4 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

This paper describes a general program for the elastic analysis of frameworks, pipeworks and framed shells which has been constructed using the facilities of the UNCLE finite element scheme.

24555 Ductile fracture theories for pressurized pipes and containers. Erdogan, F. (Lehigh Univ., Bethlehem, Pa. (USA)). pp vp, Paper F3/1 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24556 Fracture of nuclear reactor tubes. Folias, E.S. (Utah Univ., Salt Lake City (USA)). pp 7p, Paper C4/5 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

In general, fracture in nuclear reactor tubes is initiated by some flaw or imperfection, such as a microcrack, which, like a notch, induces high stresses in that vicinity. For a sufficiently high value of the local stress, the atomic bonds at the crack edge may be broken. When this happens, the flaw may grow into a sizable fracture surface, thus causing complete failure of the structure. However, because the analytical treatment of the strength of atomic bonds is not quite straightforward, the author adopts here the the continuum mechanics approach in order to derive a fracture criterion that designers can use in order to predict a priori catastrophic failures in nuclear reactor tubes by knowing only the structural geometry, crack length, ultimate and yield stress, and finally the fracture toughness K. To accomplish this, the author discusses first the stress distribution in the vicinity of a through-the-thickness line crack that has an arbitrary orientation with respect to the axis of symmetry. He then makes an energy balance for crack initiation and thus recovers the desired fracture criterion. Furthermore, he introduces correction factor to account for the plastic zone ahead of the crack tip and remarks on the effect of thickness. The theoretical results then are compared with the experimental data available in the literature and their close agreement substantiates the validity and the potential use of the proposed criterion.

24557 Experimental investigation of the vibrations of a cylinder hemisphere shell combination. Galletly, G.D.; Mistry, J. (Liverpool Univ. (UK). Dept. of Mechanical Engineering). pp vp, Paper F8/5 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24558 Creep design of thin pressure vessel end closures. Goodman, A.M. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). pp 16p, Paper G2/5 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Recent analytical work on the creep of structures has paid increasing attention to concepts of creep damage. Locally severe creep damage will give rise to an enhanced (tertiary) creep rate for a given stress, leading to further load-shedding and delaying rupture. Simplified design methods can be proposed assuming this behaviour. For infinite ductility, failure will be by collapse as a mechanism. However, generating plant components are intended for long lives, when a limited material ductility must be considered. Also, for thin pressure parts, the further stress redistribution is greatly restricted by the need to satisfy equilibrium, resulting in high tertiary strain rates. The problem is investigated for the torispherical closure, using computer analyses which include the effects of teriary creep and shape changes. The results are compared with the predictions of approximate methods, for which suitable adjustments are suggested. Changes of shape are shown to be advantageous.

24559 Practical method for computing the deflection of beams and tubes caused by creep. Hibbeler, R.C. (Union Coll., Schenectady, N.Y. (USA)). pp 5p, Paper C3/3 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

In many cases, the effect of creep contributes substantially to the deflection of structural elements that comprise nuclear reactors. This paper presents a method of analysis for computing these deflections due to bending. The method of analysis considered in the paper is based upon the idea that the effect of creep bending is localized, like plastic yielding, resulting in the formation of creep hinges which are generated at points of maximum moment. The simplification allows two simplifications of the analysis; namely only one integration of the moment-curvature relation is needed rather than two, and if necessary, approximate expressions may be used in place of exact expressions in regions of maximum stress. A series of statically determinate and indeterminate examples are worked to illustrate the method. In particular it is shown that the analysis is most advantageous for statically indeterminate problems. The accuracy of the technique is shown to be dependent upon the creep exponent n, - the higher the exponent, the greater the accuracy; and the shape of the bending moment diagram, - sharp peaks enhance the effect of localized bending. Due to the simplicity of application, the method offers a usefulness for determining deflections with a degree of accuracy suitable for design and analysis.

24560 Thermal ratcheting in pressure vessels and piping. Kalnins, A.; Updike, D.P. (Lehigh Univ., Bethlehem, Pa. (USA)). pp 9p, Paper F3/6 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

During its lifetime, a nuclear power plant can experience cyclic thermal loading produced during start-ups and shut-downs. Under such conditions, pressure vessels, piping and other components can experience accumulative dimensional changes through thermal ratcheting. Such dimensional changes can occur when cyclic thermal loading is superposed upon steady mechanical loading. Simplified models based on one-dimensional plastic stress-strain relations, as proposed by Miller, Bree and Burgreen, are currently used by designers to estimate the likelihood and the amount of ratcheting during the life of the component. It is shown in this paper that the Miller-Bree-Burgreen one-dimensional model is applicable when the ratio of the steady membrane stresses is larger than one-half (Nsub(y)/Nsub(x)<1/2), which includes such significant applications as cylindrical and spherical vessels under internal pressure. For the stress ratios approaching minus one, the biaxial model predicts much higher ratchet strain. Examples where such states occur are the knuckle region in pressure vessels with torispherical heads and pipe connections under torsion. Designers should be alerted to such a limitation of the presently used ratcheting model.

24561 Surface flaw in a thermally shocked hollow cylinder. Kobayashi, A.S.; Emery, A.F.; Polvanich, N.; Love, W.J. (Washington Univ., Seattle (USA). Dept. of Mechanical Engineering). pp 11p, Paper G4/3 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The objective of this paper is to illustrate a procedure for estimating the stress intensity factors of a semi-elliptical crack located in the inner or outer surface of a thermally shocked hollow cylinder. The first step in this procedure is to estimate the transient thermal elastic stresses induced by sudden cooling of an uncracked cylinder by numerically evaluating standard heat transfer and thermal stress formulae. The stresses at the location of the crack surface in the uncracked cylinder are eliminated by the method of superposition in order to obtain a stress free crack surface. The stress intensity factors are then determined by a judicious use of two sets of solutions, one set involving stress intensity factors for a semi-elliptical crack in a flat plate and subjected to a polynomial distribution of

pressure loading, and another set involving single-edge notched plates with prescribed edge-displacements and single-edge internally or externally notched cylinders with thermal shock loading.

24562 Some comments on the treatment of thermal stresses in ASME Nuclear Vessel Code. Krieg, R. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorentwicklung); Ahmed, H. (Argonne National Lab., Ill. (USA)). pp 10p, Paper F3/2 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The mechanical design of nuclear power plants is largely dependent on the rules laid down in the ASME Boiler and Pressure Vessel Code, Section III (1968). Due to a very complicated but intelligent arrangement considering several conditions and stress categories this code provides relatively high safety as well as economically reasonable design. It seems to be difficult to find situations where components have failed after having met the design requirements of Section III. However, as there are some exceptions to every rule, there are some special cases in which the code rules offer very limited conservatism, if any, and safety of components designed to Code rules become questionable. For instance critical cases in which the ASME Code is not appropriate may arise from some thermal stress problems. For a special loop construction the linear elastic stress analysis, as required by the ASME nuclear pressure vessel code, is compared with a more realistic elastic plastic analysis. It turns out that in this particular case where thermal stresses are predominant the application of shakedown condition leads to unusually low safety factors. Two other examples, a piping system and a vessel with nozzle to which application of the ASME-Code might lead to similar problems are mentioned.

24563 Effect of shell discontinuities upon one another. Kurajian, G.M. (Michigan Univ., Ann Arbor (USA). Dept. of Mechanical Engineering); Stewart, R.B. (Chrysler Corp., Detroit, Mich. (USA)). pp 11p, Paper G1/7 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

This paper develops formulations and an accompanying procedure for the determination of the stress effects of one shell discontinuity upon another, whether the discontinuities are of shape, thickness or material or any combination thereof. This effect is named the Transfer Effect by the authors. Further, the applicability is to embrace any thin elastic composite shell of revolution which is axisymmetrically loaded. A sample problem, that of a pressure vessel bulkhead, is employed to illustrate the features and use of the method developed.

24564 Evaluation of structural performance characteristics and improvements in the dynamic analysis of piping systems. Leimbach, K.R. (Bochum Univ. (Germany, F.R.)); Schmid, H.J. (Kraftwerk Union A.G., Offenbach (Germany, F.R.)). pp 14p, Paper F4/6 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The increasing complexity of nuclear piping systems might make it necessary to deviate from strictly conventional methods and make use of modified techniques. This is especially true for the dynamic analysis of large size multi-degree-of freedom systems, where the size of the problem might very well exceed the capacity of the computer or make it impossible to maintain a minimum of accuracy. For this reason three areas are described, which deal with problems associated with dynamic analysis by computers. First a method of decreasing the size of a dynamic problem is discussed. The second point covers the difficulties associated with closely spaced modes. The last chapter covers the means of finding a representative response spectrum of a system, excited at several different points. The possibility of finding a representative point with its associated response spectrum closely approximating the real spectrum for multi-mass-points excitation is discussed.

24565 Validation of the dynamic structural integrity of a nuclear piping component using static inelastic modelling technique. Leonard, J.W. (Illinois Inst. of Tech., Chicago (USA). Dept. of Civil Engineering); O'Leary, J.R. (Texas Univ., Austin (USA)). pp 13p, Paper F4/9 of In Structural mechanics in resctor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

This paper presents the results of a numerical stress analysis performed for the disk and seat region of the 30 in. main steam check valve installed in a nuclear power station. The stresses and strains are predicted subsequent to a postulated rupture in the main steam line between the steam generator and the containment isolation valve. This study was prompted by the existence of extreme impact forces generated by closure of the check valve under the postulated rupture. This analysis was undertaken to determine the extent of inelastic behavior.

24566 Calculation of added water mass effects for reactor system components. Levy, S.; Wilkinson, J.P.D. (General Electric Co., Schenectady, N.Y. (USA)). pp 14p, Paper F2/5 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The vibrations of many components of reactor systems such as heat exchanger tubes and rectangular channels are greatly affected by the interaction of these components with the surrounding water. The inertial properties of the water can be represented by an added mass matrix, which is an expression of such interaction. A computational approach is presented, based on the finite element method, for deriving the added mass matrix of complex systems of components. The method is two-dimensional, and is valid for long axial bodies of arbitary cross section which are defined by a nodal grid. The results are expressed in mass per unit axial length. No account is taken of end leakage and similar effects. The method is based on the successive solutions of Laplace's equation for a number of fundamental boundary conditions (in which each body in turn is given a unit acceleration in two orthogonal directions, one at a time). Examples are given concerning the added mass matrices of well known configurations (for instance, concentric cylinders) in order to demonstrate the accuracy of the method. Examples are also given of more complex configurations involving pipes and channels found in reactors.

24567 Homogeneous boundary value problem of the thick spherical shell. Linder, F. (Control Data GmbH, Frankfurt am Main, F.R. Germany). pp 11p, Paper G2/7 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

With the aim to solve boundary value problems in the same manner as is attained in thin shell theory (Superposition of Membrane solution to solution of boundary values), one has to search solutions of the equations of equilibrium of the three dimensional thick shell which produce tensions at the cut edge and are zero on the whole shell surface inside and outside. This problem was solved with the premissions of the linear theory of Elasticity. The gained solution is exact and contains the symmetric and non-symmetric behaviour and is described in relatively short analytical expressions for the deformations and tensions, after the problem of the coupled system had been solved. The static condition of the two surfaces (zero tension) leads to a homogeneous system of complex equations with the index of the Legendre spherical function as Eigenvalue. One symmetrical case is calculated numerically and is compared with the method of finite elements. This comparison results in good accordance.

24568 Modelling structural systems for transient response analysis. Melosh, R.J. (MARC Analysis Research Corporation, Palo Alto, Calif., USA). pp 10p, Paper F4/5 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

This paper introduces and reports success of a direct means of determining the time periods in which a structural system behaves as a linear system. Numerical results are based on post fracture transient analyses of simplified nuclear piping systems. Knowledge of the linear response ranges will lead to improved analysis-test correlation and more efficient analyses. It permits direct use of data from physical tests in analysis and simplication of the analytical model and interpretation of its behaviour. The paper presents a procedure for deducing linearity based on transient responses. Given the forcing functions and responses of discrete points of the system at various times, the process produces evidence of linearity and quantifies an adequate set of equations of motion. Results of use of the process with linear and nonlinear analyses of piping systems with damping illustrate its success. Results cover the application to data from mathematical system responses.

24569 Method for estimating the elastic-plastic strain capacity of structural components containing surface cracks. Merkle, J.G. (Oak Ridge National Lab., Tenn. (USA)). pp vp, Paper G4/9 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

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24570 Ultimate strength design of prestressed concrete reactor vessels. Meyer, C.; Goldman, B.I. (Stone and Webster Engineering

Corp., Boston, Mass. (USA)). pp vp, Paper H4/8 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24571 Consequences of 'hot spots' on PCRVs. Mitterbacher, P.; Schwiers, H.G. (Hochtemperatur-Reaktorbau G.m.b.H., Mannheim (Germany, F.R.)). pp 8p, Paper H3/7 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975). (In German)

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The concrete walls of the PCRVs shall be protected from the high temperatures of the reactors coolant by means of the heat protection system, i.e. insulation and cooling. For large areas of the inside face of the vessel, the concrete temperatures generally lie between 40°C to 70°C. Should the insulation be damaged, the above temperatures could be greatly exceeded, depending on the extent of the damage and the effectiveness of the cooling system. Although the method of fixing the insulation to the liner is more than adequate, a constant check is to be kept of the insulation effectiveness. The cooling system lends itself to such a check. A deterioration in the insulation would result automatically in an additional rise in temperature of the cooling water. By checking the cooling water at entry and exit with thermometers and feeding this information to a simpe computer, temperature changes in the cooling water of about 1°C and above can be detected with certainty. This temperature rise of about 1°C corresponds to an area of completely damaged insulation of less than 1 m^2 up to a few m^2 depending on the prevailing thermal conditions. It can be generally concluded from calculations on the THTR-300 reactor that because of the constant check on the liner cooling system, all damage to the insulation which could impair the PCRV integrity can be detected.

24572 Shakedown of a torispherical drumhead made from a strain hardening material. Moreton, D.N.; Moffat, D.G. (Liverpool Univ. (UK). Dept. of Mechanical Engineering). pp 14p, Paper G2/6 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Shakedown to elastic conditions has been used as a structural design criterion for some years now, although most of the applications have been to components made from materials assumed to have elastic/perfectly plastic stress/strain behaviour. This work develops an understanding of shakedown behaviour in components made from strain hardening materials. A stainless steel 321 torispherical drumhead, geometrically similar to a mild steel head used in an earlier investigation, has been machined from a solid billet and extensively strain gauged. The elastic stress distributions are presented and are compared with numerical predictions.

24573 Buckling analysis of the hot liner of the Austrian PCRV-concept. Mutzl, J. (Vereinigte Oesterreichische Eisen- und Stahlwerke A.G. (VOeEST) - Alpine Montan, Linz); Walluschek-Wallfeld, W. (Reaktorbau Forschungs- und Baugesellschaft m.b.H. und Co., Graz, Austria). pp vp, Paper H3/9 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24574 Structurally compatible fluid finite element for solid fluid interaction studies. Nahavandi, A.N.; Pedrido, R.R. (Newark Coll. of Engineering, N.J. (USA)); Bohm, G.J. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). PWR Systems Div.). pp 12p, Paper F2/2 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

This study develops a fluid finite element compatible with existing structural finite elements with the ultimate objective of analyzing solid fluid interaction problems. This type of problem is of interest in the design of nuclear reactor components involving geometric complexities and nonlinearities.

24575 Dynamic response of elastic plates subject to nonstationary random excitation. Nash, W.A.; Kanematsu, H. (Massachusetts Univ., Amherst (USA)). pp 7p, Paper F8/7 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Flat plate-like structural components of many types of reactors are often subjected to forces that vary in a random manner with respect to time. For simplicity, these random processes (pressures and forces) are often represented as stationary, i.e. statistical characteristics are invariant with time. However, a more realistic representation is to regard them as nonstationary. A few studies have previously been carried out by other investigators in an effort to determine response of linear mechanical systems to various types of nonstationary excitation, the linearity implying relatively small exciting forces. However, for plates subject to intensive dynamic forces, the plate motions are described by a pair of coupled nonlinear partial differential equations involving the lateral deflection and a stress (potential) function as unknowns. The objective of the present investigation is to present a technique applicable to prediction of structural response of nonlinear systems to nonstationary excitation. The nonlinearity considered is a geometric one due to finite amplitude responses of the plate to the exciting forces.

24576 Safety design of a PCRV with hot liner and elevated wall temperature. Nemet, J. (Reaktorbau Forschungs- und Baugesellschaft mbH und Co., Seibersdorf, Austria); Kopp, H.; Jungmann, A. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)); Zwingenberger, L. (Vereinigte Oesterreichische Eisen- und Stahlwerke A.G. (VOeEST) - Alpine Montan, Linz). pp vp, Paper H3/3 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

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24577 Limit design of perforated cylindrical shells. Porowski, J.S. (Prosynchem, Gliwice, Poland); O'Donnell, W.J. (O'Donnell and Associates, Inc., Pittsburgh, Penn., USA). pp vp, Paper F7/10 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

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24578 Probabilistic determination of partial safety factors for the design of prestressed concrete high-pressure vessels. Rackwitz, R. (Technische Univ. Muenchen (Germany, F.R.)). pp H2/9 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

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24579 Analysis of cracked pressure vessel nozzles by finite elements. Reynen, J. (Commission of the European Communities, Ispra (Italy). Joint Research Centre). pp G5/1 1-13 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

In order to assess the safety of pressure vessel nozzles, the analysis should take into account cracks. The paper describes various algorithms with their computer implementations and relative merits to define in an effective way strain energy release rates along the tip front of arbitrary 3 D cracks under arbitary load including thermal strains. These techniques are basically equivalent to substructuring techniques and consequently they can be implemented to only FEM programs able to deal with the data handling problems of the substructuring technique. Examples are given carried out with a substructure version of the BERSAFE system. These examples include a corner crack in a pressure vessel nozzle loaded by internal pressure and by thermal stresses.

24580 Lower bound limit pressure of a flush radial cylindrical branch in a cylindrical pressure vessel. Robinson, M. (Univ. of Manchester Institute of Science and Technology, Manchester (UK). Dept. of Civil and Structural Engineering). pp G1/6 1-12 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Using thin-shell theory and a non-linear optimization method, lower bounds have been obtained to the limit pressure for a radial cylindrical nozzle in a cylindrical pressure vessel. The independent variables for the optimization were chosen for each shell to be the three bending moments, and all other stress resultants were obtained in terms of these. The yield surface used was one proposed by Ilyushin, and this criterion was imposed at a finite number of points on the two shells. Force and moment equilibrium at the junction of the two shells was satisfied in an approximate overall manner using a quadratic inequality. At the end of the optimization a very accurate

yield surface , due to Ivanov, was computed at a large number of points, and forces and tangential moment at the junction were printed out for each shell at one degree intervals. The method is valid for radial nozzles of any size and results have been presented for the case of nozzle and vessel of equal strength.

24581 Ultimate load analysis of prestressed concrete reactor pressure vessels considering a general material law. Schimmelpfennig, K. (Bochum Univ. (Germany, F.R.)). pp H4/6 1-17 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975). (In German)

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

A method of analysis is presented, by which progressive fracture processes in axisymmetric prestressed concrete pressure vessels during increasing internal pressure can be evaulated by means of a continuum calculation considering a general material law. Formulations used in the analysis concerning material behaviour are derived on one hand from appropriate results of testing small concrete specimens, and are on the other hand gained by parametric studies in order to solve questions still existing by recalulating fracture tests on concrete bodies with more complex states of stress. Due attention is focussed on investigating the behaviour of construction members subjected to high shear forces (end slabs.).

24582 Strain measurements at high temperature in a concrete structure representing a cylindrical section of a PCRV with hot liner. Schittenhelm, C.; Angeli, R. (Studiengesellschaft fuer Atomenergie, Ges.m.b.H., Siebersdorf, Austria). pp H1/10 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

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24583 Growth characteristics of surface flaws in pressure vessels. Sih, G.G.; Hartranft, R.J. (Lehigh Univ., Bethlehem, Pa. (USA)). pp G4/2 1-12 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

A method of generating the variation of energy release rate along a surface crack front in a pressure vessel is discussed. Two examples of possible assumptions and the resulting consequences for crack growth are given. These and other assumptions may be checked with various compliance tests on pressurized vessels as is standard procedure in fracture mechanics. Special attention is given to the growth of a semi-elliptical surface flaw, and parameters are included which may be used to match the calculated results with experimental observations. The method is applicable to surface flaws of other shapes.

24584 Dynamic analysis of steam isolation valve for closure under faulted conditions. Slot, Th. (Teledyne Materials Research Co., Waltham, Mass. (USA)); Batum, O. (Southern Services, Inc., Birmingham, Alabama, USA); Genier, R.A. (Atwood and Morrill Company, Salem, Mass., USA). pp F6/10 1-14 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The paper is concerned with an evaluation of the structural response of a swing-disk steam-isolation valve in the event of an emergency closure, such as postulated in conjunction with a pipe break in a main steam line of a nuclear power station. Described are the analytical approach, the results obtained from the dynamic analysis, and the acceptance criteria adopted for evaluating the results.

24585 Presssure vessel integrity and weld inspection procedure. Solomon, K.A.; Okrent, D.; Kastenberg, W.E. (California Univ., Los Angeles (USA). School of Engineering and Applied Science). pp G3/5 1-11 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The paper develops a simple methodology which, when coupled with existing observations on pressure vessel behaviour, provides an inter-relation between pressure vessel integrity and the parameters of the in-service inspection program, including inspection sample size, frequency, and efficiency. A modified Markov process is employed and a computer code was written to obtain numerical results.

24586 Deformation behaviour of large, high-pressure vessel flanges. Spaas, H.A.C.M.; Latzko, D.G.H. (Delft Univ. of Technology (Netherlands). Lab. for Thermal Power and Nuclear Engineering). pp G1/4 1-10 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The analysis of the deformation behaviour of large high-pressure vessel flanges poses a much more difficult problem than for low-pressure flanges due to their particular geometry. The narrow flange faces cause the gasket reaction moments to be relatively large as compared to the bolting moment, thereby requiring an exact knowledge of the radii of application of these reactions. The general problem of the elastic analysis of such flanges can be solved by a schematization of the flanges by perfectly rigid rings joined to cylindrical and spherical shells. Recently this approach was further refined with respect to the influences of local gasket geometry, bolt behaviour and gasket closing and opening mechanism. However, none of these approaches has taken into consideration the detailed effects of plastic deformation of the gasket faces. Furthermore, experimental information obtained on full-scale reactor vessels indicates that the approximation of the flange rings may lead to erroneous results when coupled to the assumption of purely elastic behaviour of the gasket faces. The paper supplies information on these latter subjects. Results obtained indicate that for high-pressure flanges of the narrow design investigated the deformation behaviour is best described by an elasto-plastic finite element analysis. Where the rigid ring concept is retained for practical purposes a correction factor for local plastic behaviour of the gasket faces is suggested.

24587 Creep bending of short radius pipe bends. Spence, J. (Strathclyde Univ., Glasgow (UK). Dept. of Mechanics of Materials). pp F6/2 1-11 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

There is some existing theoretical work on the creep behaviour of smooth curved pipes which refers to long radius bends where the radius of curvature (R) is assumed to be much greater than the cross-sectional radius (r). The paper extends the previous work and presents a theoretical analysis of the stationary creep of a short radius pipe bend under in-plane bending loading.

24588 Inelastic analysis of a multicavity PCRV under internal pressure. Takeda, T.; Yamaguchi, T.; Imoto, K. (Structural Engineering Lab., Technical Research Inst., Ohbayashi-Gumi, Ltd., Kiyose-shi, Tokyo, Japan). pp H2/5 1-13 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The paper examines two different methods of inelastic analysis, the two- and the three-dimensional finite element technique, and discusses the capabilities of both methods of analysis for a multicavity prestressed concrete reactor vessel (a multicavity PCRV). The multicavity PCRV under investigation is a thick-walled cylindrical model for a multicavity structure with six additional cavities located in the barrel wall, both ends of which are bounded by two slabs. It is mounted on a star-shaped pedestal monolithically cast with the PCRV bottom slab and the base mat, and in the top head slab, a number of refueling penetrations are provided.

24589 Elastic analysis of a heat exchanger piping using the finite element method. Teramae, T. (Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan)). pp F7/4 1-10 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

An elastic-plastic creep analysis based on the finite element method is performed to determine the structural response of heat exchanger piping subjected to mechanical and thermal loading. The piping is comprised of a set of straight frame members. For the plastic analysis, the isotropic and Ziegler's kinematic hardening rules are employed. The creep law under uniaxial stress state is extended to give a generalized expression for multiaxial stress state. The combined strain-hardening and time-hardening procedure proposed by Cozzarelli and Shaw is adopted for the creep behavior under varying stress state. An incremental equilibrium equation is obtained using the virtual displacement principle. Element stiffness and nodal forces are calculated by numerical integration. The method to control the amount of increment is proposed since it highly influences the precision and the stability of calculations. Geometrical nonlinearity is considered to discuss the structural instability phenomena. A computer program, considering the above mentioned factors, is developed to analyse the creep buckling, ratchetting and other phenomena which are very important in the design of nuclear power plant components. The feasibility of this formulation is shown through several numerical examples.

24590 Shell theory analysis of pure in-plane bending of a pipe bend. Thompson, J.J. (New South Wales Univ., Kensington (Australia). School of Nuclear Engineering). pp F6/1 1-9 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The Fluegge theory has been applied to a pipe bend, as a toroidal shell, to calculate stresses, displacements and flexibilities due to both pure in-plane bending and internal pressure. Sufficient terms have been used in the Fourier Series expansion of the circumferential and radial displacement to ensure convergence, and results are given for a range of pipe factors and wall thickness ratios.

24591 Experience in the application of a finite element system to the analysis of complex prestressed concrete pressure vessels. Wade, M.J. (Imperial Chemical Industries Ltd., Billingham (UK)); Henrywood, R.K. (Atkins Research and Development, Epsom, U.K.). pp H2/3 1-11 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The increasing geometric complexity of PCPVs requires an accurate mathematical idealization of the shape of the structure. Finite elements of the isoparametric type provide one answer to this problem. The commercial availability of finite element analysis packages requires the designer to make a careful selection of a suitable package and adapt and extend that system to suit his particular needs. The application by Taywood Engineering Ltd., of the Atkins Stress Analysis System (ASAS) to the analysis of complex multi-podded PCPVs is discussed.

24592 Fracture mechanics of weldments using finite elements. Younan, M.Y.A.; Dewey, B.R.; Akin, J.E. (Tennessee Univ., Knoxville (USA)). pp G5/2 1-10 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

It is established that weldments are non-homogeneous anisotropic materials. Hence a new fracture criterion is necessary to predict critical directions for crack propagation as well as critical loads. The proposed criterion is that the crack will propagate in a direction so that the energy release rate is stationary. The magnitude of the critical energy release rate is a material property which is dependent upon the structure of the weldments. To utilize this criterion an existing two-dimensional finite element code has been modified. The theory explains crack branching and irregular crack-propagation directions observed experimentally. The results find immediate application in the prediction of subcritical crack growth in weld metal, and represent an improvement over previous work which treated weld metal as a homogeneous, isotropic material.

24593 Instrumentation of the prestressed concrete pressure vessel with hot liner at Seibersdorf Research Centre. Zemann, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Forschungszentrum); Angeli, R. (Reaktorbau Forschungs- und Baugesellschaft Ges. m.b.H., Seibersdorf, Austria). pp H3/10 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24594 Dynamic response of pressure vessels in the non-linear range to impulsive loading. Zienkiewicz, O.C.; Owen, D.R.J. (University Coll. of Swansea (UK)); Shantaram, D. (Osmania Univ., Hyderabad (India)). pp E4/1 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24595 Failure mode analysis of a PCRV. Influence of some hypothesis. Zimmermann, Th.; Saugy, B.; Rebora, B. (Ecole Polytechnique Federale, Lausanne (Switzerland)). pp v.3 p.H4/3 1-12 of In Structural mechanics in reactor technology. Jaeger, T.A. (comp.) (Bundesanstalt fuer Materialpruefung, Berlin (Germany, F.R.)). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The most recent developments and results obtained using a mathematical model for the non-linear analysis of massive reinforced and prestressed concrete structures are described. The method is based on three-dimensional isoparametric finite elements. A linear solution is adapted step by step to the idealized laws of the materials up to the failure of the structure. The paper aims mainly to demonstrate the accuracy of a failure analysis by three-dimensional finite-elements and to compare it with a model test, in particular when complete deformation and failure tests of the materials are available.

24596 Steam generator for nuclear power plants and heat centrals. Krizek, V.; Quitta, R.; Rybnicek, I.; Riman, I.; Manek, O.; Kubacek, A. Czech Patent 156,727. 15 Feb 1975. 5p. (In Czech).

A steam generator for nuclear power plants and nuclear power and heating plants is proposed using pressurized water, organic material or liquid metals as a coolant. The heated surface is formed by at least two parallel cylindrical elements with U pipes. The cylindrical elements are arranged parallel under the steam chamber and the element cladding on the primary coolant side is connected to a common symmetrical input and output collector provided with manholes. It is recommended that the steam chamber with the heat transfer elements and inlet and outlet pipes be placed in the supporting steam generator structure.

24597 Heat exchanger for nuclear power plants and heat centrals. Masek, V.; Riman, J. Czech Patent 157,488. 15 Apr 1975. 3p. (In Czech).

A heat exchanger for nuclear power plants and power and heating plants is proposed using pressurized water, organic material or liquid metals as a coolant. The bundle of heat transfer U pipes is partitioned into the heating, evaporating, and overheating parts. Feedwater enters via a distribution chamber while steam exits through a collecting chamber; the two chambers are contiguous and are separated by a partition.

24598 Method for making mouldings through melting in an electro-conductive slag, and an installation for carrying out said method. Rabinovich, V.I.; Kriger, J.N.; Karpov, O.S.; Sapunov, V.E.; Karpov, V.A.; Kovenya, V.Y. French Patent 2,268,588/A/. 23 Apr 1975. 22p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 25 Apr 1974; 15 May 1974, SU.

The method forming the object of the invention is of the type comprising melting an electrode in a slag-bath with simultaneous welding of a pre-fabricated member, and it is characterized in that the welding-operation is carried out initially while dipping the member to be welded into the slag-bath down to a level between 2/10 and 6/10 of the depth of said bath. The invention can be applied, in particular, to the manufacture of covers and of tapping devices for atomic power generators.

24599 Telescoping reflecting thermally-insulating element. Oser, N.; Niedzinski, E.J.; Kubicek, J.; Lewis, R.L. (to Johns-Manville Corp.). French Patent 2,271,493/A/. 12 May 1975. 14p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 13 May 1974, US.

The invention relates to thermally-insulating elements. It deals with an insulating element constituted by two telescopic parts, each of which comprises an outer envelope and an inner envelope, and sheets adapted to slide with respect to each other, a bolt prohibiting the disassembly of the whole device. This can be applied to the thermal insulation of reactors and pipes in nuclear power-stations.

24600 Safe closing device for freely-floating piston valves. Martin, H.F. (to Westinghouse Electric Corp.). French Patent 2,271,476/A/. 13 May 1975. 7p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 14 May 1974, US.

The present invention relates to freely-floating piston valves. A valve-piston can be displaced in a valve-body through the closing and opening of a first control-valve for generating a vacuum. A tank is put in communication with the valve actuating chamber, communication being interrupted by a second control-valve when the first control-valve is open for opening the piston-valve. For closing the piston valve, the first control-valve is closed and the second control-valve is open for feeding the valve actuating chamber with pressurized fluid from said tank. This can be applied to nuclear power stations (turbine valves).

24601 Steam-generator with a moisture-separator. Bennett, R.R. (to Westinghouse Electric Corp.). French Patent 2,275,731/A/. 18 Jun 1975. 7p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 21 Jun 1974, US.

Description is given of a steam-generator comprising a heat-exchange portion and a steam-collecting portion. The heat-exchange portion is enclosed in a jacket, whereas the steam-collecting portion is constituted by a plate provided with openings, comprising steam-tubes extending between said jacket and the plate. Said steam-tubes provided with moisture-separators, are constituted by two telescopic portions, one of which is connected with the jacket, whereas the other is connected with the plate provided with openings. Such an arrangement renders the steam-generator easier, and accomodates differences of expansion between the jacket and the envelope of the generator.

24602 System for the discharge of gas bubbles from the coolant flow of a nuclear reactor cooled by forced circulation. Markfort, D.;

Kaiser, A.; Dohmen, A. (to Internationale Atomreaktorbau G.m.b.H. (INTERATOM)). German(FRG) Patent 1,815,047/B/. 3 Jul 1975. 3p. (In German).
2 figs.

In a reactor cooled by forced circulation the gas bubbles carried along with the coolant flow are separated before entering the reactor core or forced away into the external zones. For this purpose the coolant is radially guided into a plenum below the core and deflected to a tangential direction by means of flow guide elements. The flow runs spirally downwards. On the bubbles, during their dwell time in this channel, the buoyant force and a force towards the axis of symmetry of the tank are exerted. The major part of the coolant is directed into a radial direction by means of a guiding apparatus in the lower section of the channel and guided through a chimney in the plenum to the center of the reactor core. This inner chimney is enclosed by an outer chimney for the core edge zones through which coolant with a small share of bubbles is taken away.

24603 Device for the insertion of tubes into tube plates or tube support walls, in particular for heat exchangers. Toeller, G. (to Kraftwerk Union, A.G.). German(FRG) Patent 2,213,073/B/. 28 Aug 1975. 2p. (In German).
1 fig.

The invention relates to an improvement of a slide piece of plastics, serving for introducing tubes into tube plates or tube support walls, particularly of heat exchangers, and holding them rigidly in this place. According to the invention, on the surface of the neck of the sliding piece described in German patent application P 21 43 679.3, bridge-like, axially parallel rims are provided in the range adjacent to the collar, these rims having less radial height than the collar.

24604 Industrial technique. (to Babcock and Wilcox Co.). Netherlands Patent 7,510,303/A/. 2 Sep 1975. 12p. (In Dutch).
Priority 10 Mar 1975, USA; 2 figs.

A typical embodiment of the invention detects leaking fuel rods by means of a radiation detector that measures the concentration of xenon-133 (Xe^{133}) within each individual rod. A collimated detector that provides signals related to the energy of incident radiation is aligned with one of the ends of a fuel rod. A statistically significant sample of the gamma radiation (γ-rays) that characterize Xe^{133} is accumulated through the detector. The data so accumulated indicates the presence of a concentration of Xe^{133} appropriate to a sound fuel rod, or a significantly different concentration that reflects a leaking fuel rod.

24605 Heat exchangers. (to Babcock and Wilcox Co.). Netherlands Patent 7,510,739/A/. 12 Sep 1975. 10p. (In Dutch).
Priority 3 Mar 1975, USA; 3 figs.

The tubes of a heat exchanger tube bank have a portion thereof formed in the shape of a helix, of effective radius equal to the tube radius and the space between two adjacent tubes, to tangentially contact the straight sections of the tubes immediately adjacent thereto and thereby provide support, maintain the spacing and account for differential thermal expansion thereof.

24606 Fuel element cellular grid structure and procedure to insert and withdraw fuel rods from that structure. (to Babcock and Wilcox Co.). Netherlands Patent 7,510,857/A/. 16 Sep 1975. 9p. (In Dutch).
Priority 24 Feb 1975, USA; 5 figs.

A typical embodiment of the invention provides a means for selectively inserting and withdrawing one or more fuel rods from a fuel element cellular grid structure. The transverse stubs on one side of a long, thin bar are turned through 90deg to extend across the gap between mutually perpendicular grid structure plates. The extreme ends of these stubs engage the adjacent portions of the associated plates that form part of the grid cells. Pressing the stubs against the plate portions through the application of appropriate force in a longitudinal direction relative to the bar deflects the engaged plates through a sufficient distance to enable fuel rods to be inserted into or withdrawn from respective cells. After rod insertion, the force applied to the bar is released to enable the plates to relax and engage the fuel rods. The bars are rotated once more through 90deg and withdrawn from the grid structure. A similar procedure is employed to withdraw fuel rods from the grid structure.

24607 Method of heat exchanger fabrication. Creighton, G.R. (to Ciba-Geigy A.G.). German(FRG) Patent 2,510,835/A/. 18 Sep 1975. 21p. (In German).
5 figs.

The invention avoids the disadvantages hitherto encountered in the fabrication of heat exchangers. Thin metal foils (0.01-0.8 mm or 0.05-0.25 mm thickness) are folded in zigzag shape to form a pile, are then positively interconnected with their longitudinal edges (by means of adhesive on the basis of duroplastic resins or welded or soldered) and are widened by introducing a pressure medium. The line components of the widened line preferably extend parallel to each other although they may also be bent. An example of a heat exchanger system made of an aluminium alloy connected by an adhesive is given.

24608 Burst protection system for the pressure vessel of a nuclear reactor. (to Siempelkamp Giesserei K.G.). German(FRG) Patent 2,419,033/B/. 25 Sep 1975. 5p. (In German).
2 figs.

The invention relates to the improvement of burst protection systems for nuclear reactors, the pressure vessels of which are enclosed by a burst protection jacket, the empty space therebetween serving as annular inspection space generally filled with fluid bulk material. Since the bulk material will be filled in in cold state, tensions may occur in the burst protection jacket when the pressure vessel is heated and expands and the bulk material is compressed during this action. The invention therefore proposes to provide a spacing between the bulk material and the pressure vessel by means of adjustable steel sheets. The sheets are connected to spindles which can be adjusted from the outside of the burst protection jacket. A store for bulk material is provided at the upper inlet of the inspection space.

24609 Grid for a fuel element. (to Babcock and Wilcox Co.). Netherlands Patent 7,512,522/A/. 27 Oct 1975. 10p. (In Dutch).
Priority 3 Mar 1975, USA; 3 figs.

An illustrative embodiment of the invention has one or more corrugations formed in the surface of a fuel element grid for a nuclear reactor. Not only does the corrugation enhance the strength of the grid plate in which it is formed, but it also provides a simple and convenient means for regulating the reactor coolant pressure drop through an appropriate choice of the corrugation depth.

24610 Method and device for reversing the rotation direction of a medium on the secondary side of a heat exchanger especially for power plants with nuclear reactors. Stiteler, F.Z.; Honigmann, R.L. (to Combustion Engineering, Inc.). German(FRG) Patent 2,515,268/A/. 30 Oct 1975. 13p. (In German).
3 figs.

In steam generators as they are used in nuclear power plants, it is sometimes necessary to reverse the direction of rotation of a medium on the secondary side of the exchanger. A very important application of this flow reversing is found in the chemical purification of the steam generator necessary for removing depositions of contaminations on the secondary side of the tube bundle and cover plate.

24611 Thermal, elastoplastic, and creep analyses of heat exchanger piping. Teramae, T. (Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan)). *Ishikawajima-Harima Giho;* **15**: No. 6, 680-686(Nov 1975). (In Japanese).

Formulae were derived for the thermal, elastoplastic, and creep analyses of frame structures, on which a computer program to calculate the inelastic behavior of a heat exchanger piping was developed. The load incremental procedure was employed in these analyses, and the incremental equilibrium equation was obtained by the virtual displacement principle. The element stiffness was calculated by numerical integration to evaluate accurately the incremental stress-strain relation at each integral point. The validity of this formulation was recognized through calculations with some samples and comparison between those calculation results and theoretical solutions.

24612 Behaviour of mineral insulated cables in reactor instrumentation technology. Boeck, H.; Suleiman, M.; Pirker, H. (Atominstitut der Oesterreichischen Hochschulen, Vienna). *Atomkernenergie;* **28**: No. 4, 229-237(1976). (In German).
17 figs.; 2 tabs.; 41 refs.

The signal transmission from areas of high temperature or radiation burden has to be performed with mineral insulated cables, as any other insulation material will be destroyed within a short time. The principal application field is therefore the reactor instrumentation technology where these cables are used for the signal transmission from thermocouples and miniature incore neutron detectors. A review on the main problems arising from the application of these cable types in reactor instrumentation is given. In particular the temperature and irradiation behaviour as well as the principal electrical and mechanical properties of mineral insulated cables are investigated and the relevant literature is cited.

24613 Fast analogue scanner for data acquisition on nuclear plants. Mitchell, B. (General Electric Co. Reactor Equipment Ltd., Whetstone (UK)). *G.E.C. J. Sci. Technol.;* **43**: No. 1, 37-47(1976).

An all-solid-state computer interface system has been designed specifically for nuclear power-station applications. It is capable of accepting directly low-level analogue signals such as those from thermocouples. The equipment is intended to operate in high electrical-interface levels, has a fast scanning rate, and converts plant signals into computer-compatible ones. The production of errors due to the coupling of electrical interference into the plant measuring circuits is described and a comparison is drawn up between the scheme and some read-relay-based interface systems used to date on power stations.

24614 Some fundamental considerations in the use of Freon 12 for modelling complex equipment including circulators in water reactor

systems experiencing depressurization. Porter, W.H.L. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). pp 473-483 of In Ecoulements diphasiques et cavitation dans les systemes de production d'energie. Paris; Societe Hydrotechnique de France (1976).

From Symposium on two phase flow and cavitation in power generation systems; Grenoble, France (30 Mar 1976).

The possibility of specifying useful scale freon models to investigate water-steam plant undergoing transient depressurisation effects is established by the methods of dimensional analysis. Particular attention is given to the more complex pieces of equipment such as circulators and complex pipework configurations. The paper is intended to form a groundwork for later elaboration as experience and experimental evidence is built up, and as such is intended to stimulate an appreciation of the principles involved, rather, than to give a finalized and fully authenticated set of recommendations.

24615 Use of T.V. techniques in atomic power stations. Allanson, D.; Diehl, A. pp Paper 3 of In Colloquium on CCVT in difficult environments. London; Institution of Electrical Engineers (1976).

From Colloquium on CCTV in different environments; London, UK (29 Mar 1976).

A short account is given of the use of CCTV in a number of the reactors operated by UKAEA and other UK organizations. The conditions (radiation, temperature, space, reliability) in which the equipment is required to operate are stated. The camera, cooling and control circuits are described.

24616 6.9-kV, 60-kA, metal-enclosed switchgear with Magne-blast circuit breaker. Horie, T.; Takano, I.; Sasaki, T.; Jinnai, I.; Ishihara, T. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). *Toshiba Rebyu;* **31**: No. 1, 52-55(Jan 1976). (In Japanese).

Intended for use in thermal or atomic power plants with large capacity, metal-enclosed switchgear incorporating a "Magne-blast" circuit breaker rated 6.9 kV, 60 kA, 750 MVA has been worked out. Their ratings, characteristic features, construction and test results are described. The development of aseismatic metal-enclosed switchgear with specifications peculiar to atomic power plants is also going on with good results.

24617 Nuclear reactor with prestressed metallic pressure vessel. (to Siempelkamp Giesserei K.G.). German(FRG) Patent 1,639,394/C/. 8 Jan 1976. 4p. (In German).

2 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention relates to a nuclear reactor whose metallic pressure vessel, which is prestressed from prefabricated cast-iron elements, serves for receiving the reactor core and provides for shielding at the same time. This reduces the static problems and any problems arising from heat expansion. Cast iron of rather high C contents is applied, the wall thickness is dimensioned sufficiently and at least in the area of the expansion joints of the prefabricated elements a sealing liner or sealing means is provided. The application of additional external prestressing elements is possible. The invention is illustrated by an example.

24618 Core fastening system. Brynsvold, G.V.; Snyder, H.J. Jr. (to Energy Research and Development Administration, Washington, D.C. (USA)). German(FRG) Patent 2,527,664/A/. 15 Jan 1976. 19p. (In German).

12 figs. Available from Dt. Patentamt, Muenchen (FRG).

The internal core fastening system comprises a control sleeve arranged between the bearing tube and the outer housing and exhibiting at least one protruding cam-like member and at least one member forming a shoulder.

24619 Nuclear reactor with rotatable closure head. Mohm, F. (to Internationale Atomreaktorbau G.m.b.H. (INTERATOM)). German(FRG) Patent 1,564,114/B/. 22 Jan 1976. 4p. (In German).

2 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention relates to the layout of decay channels in a nuclear reactor which has a closure head turnable eccentrically to the middle axis. For reducing the time necessary for refuelling, the decay channels are arranged on the circle described by the passing-through channel in turning the closure head at a position in the shielding different from that of the refuelling channels. A turnable auxiliary closure head facilitates the discharge procedure.

24620 Method of operation for a nuclear power plant. Barleon, L.; Dalle Donne, M.; Dorner, S. (to Gesellschaft fuer Kernforschung m.b.H.). German(FRG) Patent 2,433,304/A/. 22 Jan 1976. 9p. (In German).

Available from Dt. Patentamt, Muenchen (FRG).

A method for the operation of a nuclear power plant is described whose primary coolant circuit contains liquid metal as coolant, and for whose secondary circuit which is coupled to the first by means of heat exchangers, one or more chemical compositions dissociating at higher temperatures and recombining at lower temperatures or associating into the original types are used as operating medium. N_2O_4 is suggested as operating medium, and metal halogenides e.g. Al_2Cl_6, Al_2Br_6 are also cited as suitable. Corrosion dangers are regarded as low.

24621 Steam generator. Ritz, L. (to Gesellschaft fuer Kernforschung m.b.H.). German(FRG) Patent 1,551,022/C/. 22 Jan 1976. 2p. (In German).

1 fig. Available from Dt. Patentamt, Muenchen (FRG).

The invention relates to the most efficient design of a steam generator by means of which the live steam in a steam-cooled nuclear reactor is treated before it is supplied to the reactor for overheating. According to the invention, the discharge tube is guided downwards to the hot-steam distributor connected to a feed tube. In the section between hot-steam distributor and exit opening of the evaporator vessel, wall openings are provided through which the live steam is conducted and after-dried.

24622 Pressure vessel, in particular reactor pressure vessel. (to Siempopeikamp Giesserei K.G.). German(FRG) Patent 2,433,521/A/. 22 Jan 1976. 11p. (In German).

5 figs. Available from Dt. Patentamt, Muenchen (FRG).

The task to design the pre-stressing facility for a pressure vessel, especially for nuclear reactors, with pre-stressed jacket and pre-stressing facility, the latter one showing circumferential steel tendons supported polygonally on the outer side of the jacket by means of supporting shoes, in such a way that simply defined tensions can be generated and re-tensioning of the tendons can be carried out easily, is solved according to the invention by keeping the circumference of the steel tendons fixed and by designing the supporting shoes as stressing shoes. The defined tensions are applied through the stressing shoes.

24623 Pressure vessel for nuclear reactors. Stoll, A. (to Kraftwerk Union A.G.). German(FRG) Patent 2,032,791/B/. 22 Jan 1976. 3p. (In German).

5 figs. Addition in P 2033179.7. Available from Dt. Patentamt, Muenchen (FRG).

A pressure vessel is described which is suitable for nuclear reactors as well as for chemical process engineering. By means of a network of walls welded to one another and placed in the interior a major number of tubes are formed which are interconnected or being separately accessible according to choice. They can - separately or in groups - be provided with closing elements. The walls of the inner network are connected with the pressure vessel at several of their edges contacting the pressure vessel circumference.

24624 Nuclear power station with a water-cooled nuclear reactor. Maurer, H. (to Commission of the European Communities). German(FRG) Patent 1,589,770/B/. 5 Feb 1976. 2p. (In German).

1 fig. Available from Dt. Patentamt, Muenchen (FRG).

The invention relates to the improvement of the pressure compensation system in a nuclear power plant with a water-cooled nuclear reactor the pressure vessel of which is surrounded by a low-pressure housing which contains a water vessel for pressure suppression. It is proposed to provide further optionally openable connecting passages between these two vessels so that pressure compensation over the existing open passage between the pressure vessel and the water vessel in the low-pressure housing is not the only possible way.

24625 Nuclear facility with a closed working-gas cycle. Clermont, H.; Foerster, S.; Heil, J.; Quell, P.; Sack, B.; Singh, J.; Schroeder, B. (to Kernforschungsanlage Juelich G.m.b.H.). German(FRG) Patent 2,435,358/A/. 12 Feb 1976. 11p. (In German).

3 figs. Available from Dt. Patentamt, Muenchen (FRG).

To increase the safety of a nuclear-reactor installation with closed working-gas cycle, it is suggested to provide a concrete vessel with many chambers which lies close to the vertical inner face of the outer prestressed-concrete containment with its outer wall. The concrete vessel contains the turboset including the generator as well as all other installation components connected by means of gas tubes to the reactor core placed in a special prestressed-concrete vessel. The chambers are supplied with closures which are gas-tight and safe concerning the escape of radioactive substances. The concrete walls protect against destruction and radioactive radiation, overflow valves in the separation walls of the chambers provide for pressure regulation in the case of a rupture of gas-conducting parts.

24626 Closing device for a gas-cooled nuclear reactor. Kube, L.J. (to General Atomic Co.). German(FRG) Patent 2,535,355/A/. 19 Feb 1976. 11p. (In German).

2 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention relates to the improvement of the closing system for an opening provided for the acceptance of a heat exchanger in the high-pressure vessel of a gas-cooled nuclear reactor. This is to prevent the emerging of secondary coolant. According to the invention, it is suggested to supply the opening with a bearing ring and to install a cylinder plate larger than the bearing ring, lying transversely to the break-trough and being secured by holding

elements in such a way that they cannot be moved towards the inner space. Suitable constructional features are described in detail.

24627 Anchoring of a liner in cast-iron reactor pressure vessels. Albrecht, W.; Doerling, R. (to Steinmueller (L. u. C.) G.m.b.H.). German(FRG) Patent 2,439,706/A/. 11 Mar 1976. 5p. (In German).

1 fig. Available from Dt. Patentamt, Muenchen (FRG).

A cheap and simple anchoring of a pressure-tight vessel (liner) with the segments of a nuclear reactor pressure vessel made of cast-iron is suggested. According to the invention, the throttle faces of the picks of the liner bear T-shaped anchors which are embedded in correspondingly shaped recesses of the segments of the pressure vessel. The interspaces between anchor and recess are filled with concrete or a mixture of cement and steel balls.

24628 Device for the measurement of radioactive fission and corrosion products in nuclear reactor loops. Neeb, K.H.; Neidl, H.; Stoeckert, H. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 2,037,796/B/. 11 Mar 1976. 3p. (In German).

1 fig. Available from Dt. Patentamt, Muenchen (FRG).

In order to be able to separately monitor radioactive fission products and radioactive corrosion products in primary coolant circuits of nuclear reactors, it is proposed to provide a pipe interrupted by two three-way valves in a by-pass to the primary circuit. This pipe has another pipe between the three-way valves (equipped with a pressure-reducing valve, a degasification tank, filters, and a recirculation pump). With a movable high-resolution gamma detector measurements will now be made at suitable positions without endangering the operational personnel.

24629 Application of gas shielded arc welding and submerged arc welding for fabrication of nuclear reactor vessels. Gehani, M.L.; Rodrigues, W.D. (Larsen and Toubro Ltd., Bombay (India)). *Electr. India;* **16**: No. 5, 5-11(15 Mar 1976).

Also Published in 'Chemical Concepts' (Apr 1976) v. 3(10) p. 19-23.

The remarkable progress made in the development of know-how and expertise in the manufacture of equipment for nuclear power plants in India is outlined. Some of the specific advances made in the application of higher efficiency weld processes for fabrication of nuclear reactor vessels and the higher level of quality attained are discussed in detail. Modifications and developments in submerged arc, gas tungsten arc and gas metal arc processes for welding of calandria are discussed. Future plans for making the gas metal arc process more economical by using various gas-mixes like agron + oxygen, argon + carbon dioxide, argon + nitrogen (for copper alloys) etc., in various proportions are outlined. Quality and dimensional control exercised in these jobs of high precision are highlighted.

24630 Clamping device. Schuengel, P. (to Kloeckner und Co.). German(FRG) Patent 2,146,608/B/. 25 Mar 1976. 4p. (In German).

3 figs. Available from Dt. Patentamt, Muenchen (FRG).

A device for prestressing a multiplicity of screw bolts sitting on a hole circle id described, where a carrying ring is provided which is supported on the flange of the pressure vessel of a nuclear reactor. On the carrying ring a hydraulic cylinder is arranged, the force of which is to be guided into the screw bolt over an auxiliary bolt which may be coupled to the screw bolt.

24631 Fuel element for light- or heavy-water cooled reactors. Pearson, K.G. (to UKAEA London Office). German(FRG) Patent 2,541,200/A/. 25 Mar 1976. 9p. (In German).

5 figs. Available from Dt. Patentamt, Muenchen (FRG).

Fuel element, consisting of a bundle of nuclear fuel rods with parallel axes, held by transverse lattices in distance to each other so that interspaces for the axial flow of coolant are formed, characterized in that at least one of the interspaces is occupied by an auxiliary coolant tube extending axially and exhibiting lateral holes, through which auxiliary coolant is sprayed into the bundle, and that deflecting devices are provided extending from a transverse lattice into a position in front of the holes for deflecting a coolant beam towards those parts of the fuel element bars inaccessible to the auxiliary coolant.

24632 Nuclear reactor. Ference, E.W.; Houtman, J.L.; Waldby, R.N. (to Westinghouse Electric Corp.). German(FRG) Patent 2,538,654/A/. 1 Apr 1976. 59p. (In German).

21 figs. Available from Dt. Patentamt, Muenchen (FRG).

Nuclear reactor with a reactor vessel closed by a closure plate in which a coolant inlet chamber and a coolant outlet chamber are formed, further with a reactor core arranged between these two chambers and surrounded by a core housing, with means for conducting a coolant through the reactor core, and with a multiplicity of vertical channels conducting the heated coolant from the reactor core to the coolant outled chamber.

24633 Device for supporting a reactor pressure vessel. Heckhausen, H.J.; Zintel, J. (to Babcock - Brown Boveri Reaktor G.m.b.H.). German(FRG) Patent 2,445,225/A/. 1 Apr 1976. 7p. (In German).

3 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention relates to a device for supporting a reactor pressure vessel by means of a bearing ring which can be mounted at the biological shielding independently of concreting work.

24634 Nuclear reactor. Schabert, H.P.; Laurer, E. (to Kraftwerk Union, A.G.). German(FRG) Patent 2,446,044/A/. 1 Apr 1976. 13p. (In German).

4 figs. Available from Dt. Patentamt, Muenchen (FRG).

The main patent deals with a nuclear reactor with a safety cover and live steam tube leading to open air, equipped with a quick action stop valve with a passage cross section corresponding to the cross section of the live steam tube and with a valve head closed with the aid of a fluid in case of a leak in the live steam tube.

24635 Gas-cooled nuclear reactor with a pressure vessel with liners. Bachl, H. (to Kraftwerk Union, A.G.). German(FRG) Patent 2,342,262/B/. 1 Apr 1976. 2p. (In German).

2 figs. Available from Dt. Patentamt, Muenchen (FRG).

The claim relates to the lining of the pressure vessel with at least 2 liners, one lying in the other and partially gas-cooled. The liners are cooled by a bypass flow of the reactor coolant gasflowing through in the sequence of their arrangement. The coolant bypass flows enter the outer liner with a temperature below 0°C. The coldness required is produced from waste heat in an absorption plant. The heated bypass flows emanating from the inner liner are added to the main gas flow entering the reactor. In the case of breakdown of the operating pressure in the reactor, at least one bypass flow is switchable to an auxiliary coolant, e.g. water.

24636 Testing device for inspections and in-service tests of structural elements, in particular for the inner surfaces of pressure vessels for nuclear reactors. Figlhuber, D.; Gugel, G. (to Kraftwerk Union A.G.). German(FRG) Patent 2,417,822/B/. 8 Apr 1976. 5p. (In German).

5 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention pertains to the connection of a testing device with a measuring probe (ultrasonic probe) for tests of the inner surfaces of pressure vessels of nuclear power stations. Until now, the cable layout has always been a problem in these devices. The testing device described here has a mast with a longitudinally movable and rotating arm connected to it which carries the measuring probe. The invention proposes to provide the arm with a foldable bridge consisting of links with linged joints as a carrier for the cables. Various geometrical forms for this bridge are described.

24637 Valve for the mechanical isolation of a pipe to take up a test probe. Uecker, D.F. (to Combustion Engineering, Inc.). German(FRG) Patent 2,423,752/C/. 24 Jun 1976. 4p. (In German).

2 figs. Available from Dt. Patentamt, Muenchen (FRG).

A valve is introduced for application in a pipe in which a test probe is arranged. The valve serves to isolate the pipe in a gas-tight way, thus preventing the escape of radioactive gas or dust during operation in a nuclear reactor.

24638 Motor-driven screwing and transporting tool for pressure vessels, especially pressure vessels for nuclear reactors. Scholz, M. (to Kraftwerk Union A.G.). German(FRG) Patent 2,459,645/A/. 1 Jul 1976. 25p. (In German).

6 figs. Available from Dt. Patentamt, Muenchen (FRG).

A screwing and transporting device for tensioning and loosening the reactor pressure vessel head is described. The advantage of the tool is its ability to unscrew the stud bolts from the lower part of the pressure vessel, and therefore make them accessible for in-service inspection.

24639 Improvements in measuring apparatus. Casey, W. (to British Nuclear Fuels Ltd.). British Patent 1,442,204/B/. 14 Jul 1976. 9p.p.

Measuring apparatus is described that is suitable for gauging the wall profiles of downwardly extending channels in nuclear reactors, but which is equally applicable to channels such as pipe bores and conduits in other types of plant. The apparatus comprises a probe carrying a measuring transducer giving an electrical output. The probe support may be moved stepwise along the channel along a track between end members. An electrical conductor is provided for transmitting the electrical output of the transducer to an indicator located remote from the probe. The probe support may consist of a cable attached at one end to a winding drum, and incorporating an electrical conductor connected to the transducer. Channel engaging means are provided on the probe that permits free upward movement of the probe when the latter is suspended by the cable and moves into gripping engagement with the channel wall when the tension in the cable is relaxed.

24640 Effect of openings on the strain state of reinforced concrete containment shells for an atomic power station. Mikhailov, O.V.; Zaitsev, V.N. *Beton Zhelezobeton;* No. 8, 8-11(Aug 1976). (In Russian).

Short communication only.

24641 Training simulators for nuclear power plants. Saastamoien, J. (Nokia Electronics, Helsini (Finland)). *Kernenergie;* **19**: No. 8, 37-241(Aug 1976).

Application and design of simulators for nuclear power plant personnel training are discussed, considering the range and various ways of and the reasons for, their application, their role within the framework of operator training programmes, as well as computer hardware and software aspects. Various ways of reducing hardware and software costs of such simulators are suggested.

24642 Remotely controllable manipulator device for inspection of pressure vessels from outside, especially of nuclear power plants. Andres, H.; Gebeshuber, J.; Meusel, W. (to Maschinenfabrik Augsburg-Nuernberg (M.A.N.) A.G.). German(FRG) Patent 2,506,415/A/. 26 Aug 1976. 39p. (In German).

17 figs. Available from Dt. Patentamt, Muenchen (FRG).

A device is described, which can be installed in the annulus between reactor pressure vessel and the wall surrounding it and which remotely controlled inspects the vessel wall for damage. This is done by a rail- guided, flexible open-link chain transmitting the movement, induced by a delay device, shear and tension proof to a carriage coupled to the top of the chain and carrying the inspecting systems.

24643 Methods and limitations for in-service inspection of nuclear power plant. Jackson, H. (The MatEval NDT Co. (UK)). *Nucl. Eng. Int.;* **21**: No. 249, 61-64(Oct 1976).

As more and more nuclear power stations are now being built world-wide, so the requirements for efficient, and cost-effective, inspection during manufacture and in-service have become more formalized and stringent. Some of the in-service inspection techniques, as required by ASME XI, 1974 are examined. They include radiography, eddy current and magnetic particle inspection, dye penetrant tests, holography and acoustic methods. Important developments in automated ultrasonic inspection are discussed.

24644 Large scale test facilities to assure future turbine-generator reliability. Quick, S.L. (Westinghouse Electric Corp., Steam turbine division engineering). *Nucl. Eng. Int.;* **21**: No. 249, 59-60(Oct 1976).

Turbine-generators have been a major source of nuclear power station outages and, therefore, loss of revenue to utilities. The cost penalties of outages are increasing. solution of the complex problems involved in improving the availability of turbines and generators will be aided by new test facilities costing over $10M. The uses of a large-scale turbine test facility, and a companion large-scale generator test facility, both in operation as part of a long-term programme of reliability improvement, are discussed.

24645 Giant machine tools for reactor core supports. Hollingum, J. *Engineer;* **243**: No. 6290, 44-45(14 Oct 1976).

A machine tool, claimed to be the world's largest, for machining nuclear reactor core support units in a single piece, is described. The supports are fabricated in two sections and welded together before machining and forming a hollow workpiece 3m thick and 35 ft high. The machine is a two-column bridge with a 20 ft dia rotary table which moves under the fixed columns. Driven with a 150 hp dc motor with the speed under numerical control, it is rotated at speeds for timing and boring up to 23 rev/min, or for milling down to 0.2 rev/min, with a slow indexing speed range from 0.00045 to 0.045 rev/min.

24646 Reactor flux measurements using thermoluminescent dosimetry. McKlveen, J.W. (Arizona State Univ., Tempe); Schwenk, M. *Nucl. Technol.;* **31**: No. 2, 257-263(Nov 1976).

Thermoluminescent dosimetry (TLD) was successfully evaluated as an in-core thermal-neutron-flux determinant. The LiF crystals enriched with either ^{6}Li or ^{7}Li provided two effective neutron-gamma discrimination techniques. The first method used both types of crystals. The ^{6}LiF dosimeters, which have large thermal-neutron cross sections, detected both neutrons and gamma radiation, while the ^{7}LiF dosimeters, possessing negligible thermal-neutron attenuation characteristics, monitored the gamma component only. The dosimeters were inserted into a reactor for a known time interval and read on a commercially available detection system, and the difference in dosimeter exposure yielded a direct measure of neutron flux. The second technique used bare and cadmium-covered ^{7}LiF dosimeters. The bare crystals detected reactor gammas, while those encapsulated in cadmium measured reactor gammas plus capture gammas from the Cd(n,γ) reaction. The difference in exposures provided the capture-gamma contribution, which was proportional to reactor flux. Experiments using a subcritical and a TRIGA reactor revealed exposure rate to neutron flux sensitivities of 1.4 x 10^{-7} R/sec per phi and 2.6 x 10^{-8} R/sec per phi for the respective techniques. Accurate flux measurements were obtained over a range spanning 10^2 to 10^{12} n/(cm^2 sec). At higher fluxes, the dosimeters experienced radiation damage and readings became unreliable. The TLD results were compared against BF_3 detection, foil activation, and fission chambers to derive an empirical exposure rate to the flux conversion factor.

24647 Observations on the luminescence of α-Al_2O_3 (synthetic sapphire) in a reactor environment. Davie, R.N. Jr.; Davis, J.F. III; Schneider, R.T. (Univ. of Florida, Gainesville). *Nucl. Technol.;* **31**: No. 2, 276-278(Nov 1976).

Optical components made of α-Al_2O_3 (synthetic sapphire) are used in optical systems (nuclear-pumped lasers, fission cells, etc.) to operate in a reactor in-core environment. Absorption and luminescence, which may take place in windows or lenses exposed to a reactor environment, will falsify results of optical measurements. For this reason, the knowledge of radiation-induced properties of optical materials is necessary. Measurements concerning optical absorption and luminescence of reactor-irradiated commercially available sapphire were made. The observed luminescence exhibits peaks around 3300 and 4100 A. The 3300-A peak increases as a function of irradiation time and saturates after 30 h of irradiation. The 4100-A peak decreases monotonically. The absorption coefficient after 69 h of irradiation was measured. It ranges from 7 cm^{-1} at 3000 A to 0.5 cm^{-1} at 6000 A.

FUEL ELEMENTS

REFER ALSO TO CITATION(S) 24526, 25576

24648 Nuclear reactor fuel element assembly. Bevilacqua, F.; Krawiec, D.M. (to Combustion Engineering, Inc.). German(FRG) Patent 2,326,150/A/. 17 Jan 1974. 21p. (In German).

14 figs.

The core consists of heterogeneous fuel element groups with fuel elements and guide tubes. The support of the elements against each other is achieved by a large number of thin plates intersecting each other and forming grated strips. They are arranged in a serpentine configuration. Additional flow deflectors turbulenty mix the coolant flow near the surface of the fuel elements. Furthermore, they uniformly distribute the coolant over the surface of each fuel element. For this purpose, they consist of flat bodies with symmetrical configuration along the longitudinal and lateral axes. Each flat body has two arms originating from a base section and diverging outwards. It is arranged in the center of the flow channels and attached to the supporting grids by means of the wing-arms. The lateral edges of the wing-arms are kept at a distance from the fuel elements.

24649 Nuclear reactor fuel element assemblies. Krawiec, D.M.; Bevilacqua, F. (to Combustion Engineering, Inc.). German(FRG) Patent 2,326,151/A/. 24 Jan 1974. 25p. (In German).

21 figs.

The fuel elements of each fuel element group are separated from each other by means of a multitude of thin, intersecting plates in the from of grid strips. Flow deflectors near the surface of the fuel elements are used in order to make the coolant flow more turbulent. They are designed as vanes and arranged at a distance on the grid strips. Each deflector vane has two arms stretching in opposite directions, each one into a neighbouring channel. In outward direction, the deflector vanes are converging. The strips with the vanes can be put on the supporting grid of the fuel elements. The vane structure can be reinforced by providing distortions in the strip material near the vanes.

24650 Nuclear reactor fuel element grid. Jabsen, F.S. (to Babcock and Wilcox Co.). German(FRG) Patent 2,257,000/B/. 20 Jun 1974. 5p. (In German).

4 figs.

The grid construction consists of a group of parallel grid parts or plates arranged at equal distance. Vertical to them there are further plates, all plates having mutually engaged slots through which the mating parts can be interlaced with one another. The cells formed in this way are circumscribed by a strip of equal width. Sharp edges tending to interlace neighboring fuel elements are excluded. Therefore, all projecting parts are inclined and the slots form V-shaped bearing areas. They have a cam-type effect so that the fuel elements can glide with respect to each other. The grid construction supports the assembly of the reactor core and reduces pressure losses and distrubing neutron capture because of less structural material.

24651 Vented fuel element for nuclear reactors. Gatley, J.A.; Webb, J.; Gallie, R.R. (to UKAEA London Office). German(FRG) Patent 1,514,977/C/. 19 Sep 1974. 7p. (In German).

5 figs.

The fuel element consists of fuel rods arranged within a cladding tube with fission gas plenum. Out of the plenum, a vent pipe is provided for releasing the fission gases into the coolant. The vent pipe has a throttling effect on the fission gases so that short-lived isotopes may decay before entering the coolant. The opening of the pipe has the site of a capillary tube. Its length and other dimensions depend on the properties of the reactor, as, e.g., the amount of fission products released, the operating temperature, and

the permissible radioactivity. Its length, however, is at least equal to that of the fuel space. Especially, the pipe may be designed as a capillary tube coil. Furthermore, it may contain a washing device with, e.g., liquid sodium retaining, e.g. cesium that occurs as a fission product.

24652 Deflection analysis of a nuclear reactor fuel rod assembly. Halliday, K.R.; Horvay, G. (Massachusetts Univ., Amherst (USA)). pp D1/11 1-14 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

A procedure for analyzing the response of a frictionally coupled nuclear reactor fuel rod assembly to concentrated static loads applied at the spacer grids was developed. The analytic procedure was applied to a trial fuel rod assembly. Three types of end conditions; clamped-pinned, pinned-pinned, and the more realistic elastic-pinned were considered. It was found that both varying the mechanical coupling, and varying the configuration of the bundle had significant effects on the response of the bundle.

24653 Experimental study of the vibrations of a fuel pin model in parallel two-phase flow. Hara, F. (Tokyo Univ. of Science, Tokyo (Japan). Dept. of Mechanical Engineering). pp D2/3 1-12 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Results are reported of experiments concerning the excitation mechanism of the vibrations of a fuel pin model in parallel two-phase (air + water) flow, and it is experimentally concluded that the parametric excitation mechanism plays an important role in the vibrations of a fuel pin model which is inserted in air-water parallel 'wo-phase flow. The essential part of the experimental apparatus consists of an elastic flat strip made of stainless steel, which is clamped at its both ends in a cylindrical channel conveying the air-water two-phase fluid. The experiments are made of fifty cases of conditions of air and water flow rates.

24654 Theory of the vibrations of a fuel pin model in parallel two-phase flow. Hara, F. (Tokyo Univ. of Science, Tokyo (Japan). Dept. of Mechanical Engineering). pp D2;4 1-13 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The paper deals with the theoretical analysis of the vibrations induced by parallel two-phase (air + water) flow in a fuel pin model system and concludes that the mechanism of exciting the vibrations is mainly the so-called parametric excitation due to the quasi-periodic change of the phase fluid virtual mass, the centrifugal force, the Coriolis' force, and also the resonance of the fundamental vibration to the force caused by resultant pressure difference of the two-phase flow.

24655 Correlation between fuel pins irradiated in fast and thermal fluxes using the FRUMP fuel pin modelling program. Hayns, M.R. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). pp D1/12 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24656 Experience with the three-dimensional fuel performance model wafer. Kjaer-Pedersen, N. (Elsinore Shipbuilding and Engineering Co. Ltd. (Denmark)). pp D1/4 1-10 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Since the completion of the first version of WAFER, the Danish 3-D performance model for pelletized fuel, during the summer of 1974, an extensive program has been carried out with the purpose of verifying the model by comparing model predictions with results from the Danish fuel irradiation program. The model aims at a prediction of local stresses and strains in the cladding, especially around the ridges. The paper presents the model concepts in detail and assesses their validity by comparison of computer runs with reactor experiments.

24657 Influence of microporosity on fracture stress of pyrocarbon coatings. Krautwasser, P.; Nickel, H.; Taueber, K. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). pp C1/3 1-12 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Coated particles are available with and without a silicon carbide interlayer (SiC) between pyrocarbon coatings (PyC). The pyrocarbon has to protect the SiC-layer against mechanical damage and it has to retain the gaseous and solid fission products originating in the kernel due to fuel burnup in absence of SiC. High stresses in the outer PyC coatings are built up by irradiation induced anisotropic dimensional changes which may lead to fracture. As the integrity of the coating is of main importance, many investigations were carried out in order to measure and to maximise its fracture stress. Recent investigations on fracture behaviour of integral PyC-coatings are presented. The fracture stresses of propene, acetylene, and methane-derived pyrocarbon are measured as a function of deposition temperature and deposition rate. The variation of fracture stress due to these deposition parameters is high compared with errors due to the rather simple measuring technique. The results are discussed and compared with former fracture stress measurements on PyC rings at KFA and on flat propane PyC strips at GGA.

24658 Thermal stress analysis of hot spots in reactor fuel cladding. Leonard, J.W. (Illinois Inst. of Tech., Chicago (USA). Dept. of Civil Engineering); Ahmed, H.U. (Argonne National Lab., Ill. (USA)). pp C2/4 1-12 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

A closed-form solution procedure is presented for the thermoelastic deformation and stress analysis of cylindrical shell segments subjected to localized high temperature loadings. The classical shell equations are used, and the well-established Fourier analysis technique is evoked. In the analysis, the eighth-order partial differential equations for bending of cylindrical shells are solved assuming Fourier series expansions of temperatures, displacements, and stresses in both longitudinal and circumferential directions. Both bending and membrane behavior is considered depending on the assumed temperature gradient through the shell thickness.

24659 Analysis of stresses created in the layers of coated fuel particles by temperature changes. Martin, D.G. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). pp C1;4 1-9 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Anatical solutions for stresses created in coated fuel particles by temperature changes are derived and the most significant physical properties of the various layers which affect these stresses are identified. This then provides a greater physical appreciation of the corresponding solutions performed routinely by one of the computer codes available and also highlights current inadequacies in the input data required for these calculations.

24660 Thermal bowing of pins in fuel element clusters. McAreavey, G. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). pp D1/7 1-13 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The paper describes the theoretical basis of computer codes developed for the calculation of the elastically restrained thermal bow of pins in a fuel element cluster.

24661 Computational procedure for the bowing of reactor fuel rods. Merckx, K.R. (Exxon Nuclear Co., Richland, Wash. (USA)). pp D1/6 1-10 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Bowing of zircaloy clad fuel rods has been observed. The magnitude of the rod bow has been suggested to be dependent upon axial thrust, initial curvature, support misalignment, creep relaxation, irradiation induced growth, anisotropic creep, temperature and flux gradients, pressure differential, and pitched cross-sectional tube geometry. Local variations in cladding temperature result if rod bowing continues until rod contact. Also, in some bundle designs the control rod path can become partially restricted when excessive bow deflects rods into control rod channels. Thus, the potential for fuel rod bowing is a performance characteristic that should be evaluated. A general evaluation technique is required to establish fuel rod design parameters and fabrication limitations for proposed reactor operational conditions. The paper describes the general formulation of the finite element code, AXIBOW, developed for evaluating the potential for fuel rod bow and also describes the results of sensitivity studies run to assess the significance of the factors that are associated with rod bow.

24662 Mathematical model for the dynamics of an articulated string of fuel bundles in axial flow. Paidoussis, M.P. (McGill Univ.,

Montreal, Quebec (Canada). Dept. of Mechanical Engineering). pp D2/5 1-11 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The paper describes an analytical model for the dynamics of an articulated string of fuel bundles in axial flow, each bundle being composed of many fuel elements held between end plates, and the bundles held together by a central support tube running through the whole assembly as, for example, in the CANDU-BLW design. The model is developed on the basis of Lagrangian formulation, in which the inter-bundle stiffnesses, the bundle shear stiffnesses and gravity forces are incorporated into the potential energy of the system, the conservative part of the inviscid hydrodynamic forces are incorporated into the kinetic energy, and the nonconservative part, as well as viscous forces and presssure forces, are incorporated into the generalized forces of the system. The model is one dimensional. For a system of N bundles one has 2N generalized coordinates representing the total and the shear angular deflections.

24663 Recent results of creep and plastic collapse in reactor applications. Rashid, Y.R. (General Electric Co., San Jose, Calif. (USA). Nuclear Energy Div.). pp C2/5 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24664 Interpretation with the code COCONUT-2 of the performance of coated particle fuel. Thomson, J.M. (Societe Belge pour l'Industrie Nucleaire, Brussels). pp C1/1 1-11 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The behaviour of reference coated fuel particle during irradiation carried out in HFR, BR2, and DRAGON under various conditions has been studied with the code COCONUT-2. The first two experiments, E96-1 and E96-2 were performed in HFR at a constant average temperature of 900°C. E96-1, a short term irradiation, reached a burn-up of 2.2% FIMA and a fast neutron dose of 1.19×10^{21} EDN; E96-2, a long term irradiaton, reached a burn-up of 8.7% FIMA and a fast neutron dose of 6.87×10^{21} EDN. The two BR2 experiments, VC3 and VC5, were carried out at average temperatures of 1100°C and 1300°C respectively. The fuel of VC3 reached a burn-up of 5.8% FIMA and a fast neutron dose of 5.3×10^{21} EDN: the fuel of VC5 a burn-up of 9.5% FIMA and a dose of 6.21×10^{21} EDN. The MET V (2) irradiation has been carried out in DRAGON at an average temperature of 1400°C. This short-term irradiation experiment reached a burn-up of 0.58% FIMA and a fast neutron dose of 5.54×10^{20} EDN. For each of these experiments the fraction of broken particles calculated from the code results has been compared with the measured R/B value during irradiation and with the fraction of broken particles measured during the post-irradiation visual examinations. The modes of failure are discussed.

24665 Method of production of graphite molding powder and molding material for the production of molded graphite articles. Huschka, H.; Heit, W.; Herrmann, F.J.; Spener, G. (to Hochtemperatur-Reaktor-Brennelement G.m.b.H. (HOBEG)). German(FRG) Patent 2,348,282/A/. 24 Apr 1975. 9p. (In German).

The production of graphite molded bodies of graphite powders and phenol resins has so far required a special charged preparation of the phenol resin as well as an involved testing of the quality of each charge in order to obtain pressed objects with defined properties. The proposed process avoids this by directly displacing the graphite with the initial components for the phenol resin synthesis thus the reaction is kept under controlled conditions. Phenol and formaldehyde as well as phenol and hexamethylene-tetramine are used. The reaction times are much shorter in the presence of graphite than in the normal phenol resin synthesis, the molding powder prepared according to the invention with phenol and hexamethylene-tetramine is particularly suitable for embedding coated fuel and breeder particles. Data for molded bodies are given in 3 examples.

24666 Method of isolating spherical fuel or fertile particles for nuclear reactors. Gyarmati, E.; Muenzer, R. (to Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). German(FRG) Patent 2,054,837/C/. 24 Jul 1975. 5p. (In German).

1 fig. Available from ZAED.

A device for separating spherical fuel or fertile particles, whose diameter lies within a given range, from a loose charge is described. Furthermore, counting of the particles - even at high speeds -, measurements of their diameter, and fractionation of the particles according to their diameter is made possible. The device and its mode of operation are described.

24667 Method and system for the production of fuel rods for nuclear reactors. Meinhardt, V.; Schultz, R.; Gall, A. (to Lecentia Patent-Verwaltungs-G.m.b.H.). German(FRG) Patent 2,043,248/B/. 25 Sep 1975. 3p. (In German).

1 fig.

The invention deals with a method to produce nuclear reactor fuel rods which contain the fuel in a cladding tube and in which an alkali metal is put in the space between the fuel and cladding for better heat transfer from the fuel to the cladding. The bubble-free filling-in of the alkali metal causes difficulties; the invention suggests to carry out the filling-in of fuel and alkali metal in a horizontal position of the cladding to rinse through the free space first with alkali metal, then to fill with fuel and then with the alkali metal taking account of necessary space for the fission gas volume. Equipment to carry out this process in which all operations are carried out in a vacuum box is described.

24668 Determination of burnup and plutonium content in irradiated fuels by gamma-spectrometry measurements of radioactive fission products. Paoletti Gualandi, M.; Peroni, P. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)); Bresesti, M.; Cuypers, M.; D'Adamo, D.; Lezzoli, L. (Commission of the European Communities, Ispra (Italy). Joint Research Centre). pp 613-624 of In Safeguarding nuclear materials. Vol. 2. Vienna; IAEA (1976).

From Symposium on the safeguarding of nuclear materials; Vienna, Austria (20 Oct 1975).

Experimental and theoretical investigations were carried out on fuels irradiated in the Trino Vercellese PWR and in the Garigliano BWR, in order to study the correlations between radioactive fission products, which can be determined by means of gamma spectrometry measurements, and burnup and plutonium content. Experiments were carried out on fuel assemblies and fuel solutions (solutions from reprocessing plants and solutions of separately dissolved fuel pellets). The results of the experiments indicate that nondestructive measurements of the ^{137}Cs activity can be used for the relative burnup determination in fuel assemblies. The results of the experiments indicate also that the measurements of the $^{134}Cs/^{137}Cs$ activity ratio can be used for the relative determination of the Pu/U mass ratio in fuel assemblies and fuel solutions. However, the use of the correlation between these two quantities is strongly limited by the influence of the irradiation history.

24669 Fuel element failures caused by iodine stress corrosion. Videm, K.; Lunde, L. (Institutt for Atomenergi, Kjeller (Norway)). *Ann. Nucl. Energy;* 3: No. 5;6, 305-313(1976).

From European nuclear conference; Paris, France (Apr 1975).

Sections of unirradiated cladding tubes were plugged in both ends by mechanical seals and internally pressurized with argon containing iodine. The time to failure and the strain at failure as a function of stress was determined for tubing with different heat treatments. Fully annealed tubes suffer cracking at the lowest stress but exhibit the largest strains at failure. Elementary iodine is not necessary for stress corrosion: small amounts of iodides of zirconium, iron and aluminium can also give cracking. Moisture, however, was found to act as an inhibitor. A deformation threshold exists below which stress corrosion failure does not occur regardless of the exposure time. This deformation limit is lower the harder the tube. The deformation at failure is dependent on the deformation rate and has a minimum at 0.1%/hr. At higher deformation rates the failure deformation increases, but only slightly for hard tubes. Fuel was over-power tested at ramp rates varying between 0.26 to 30 W/cm min. For one series of fuel pins the failure deformations of 0.8% at high ramp rates were in good agreement with predictions based on stress corrosion experiments. For another series of experiments the failure deformation was surprisingly low, about 0.2%.

24670 Advanced nuclear fuel element. Adamson, M.G.; Aitken, E.A.; Rosenbaum, H.S. (to General Electric Co.). German(FRG) Patent 2,527,686/A/. 22 Jan 1976. 25p. (In German).

3 figs. Available from Dt. Patentamt, Muenchen (FRG).

It is proposed, in order to improve the properties of a fuel element, to apply a metal lining (zirconium, molybdenum, tungsten, rhenium, niobium, or alloys thereof) between nuclear fuel and outer cladding whose surface facing the fuel has a coating of one or more additives. It is possible to use additives which increase the fissile properties of the fuel (239 Pu, 235 U, boron, gadolinium), control its thermal properties (getters like SiO_2 or SiO_2-Al_2O_3 compounds) or improve its mechanical properties. Three examples for constructing and assembling such a fuel element are described.

24671 Method for the coating of work pieces and fluidized-bed furnace for the implementation of this method. Lefevre, R.L.R.; Price, M.S.T. (to Commission of the European Communities). German(FRG) Patent 2,533,135/A/. 12 Feb 1976. 17p. (In German).

7 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention deals with the improvement of the forming of the injecting region of a fluidized bed furnace in which (for example) nuclear fuel particles containing uranium, plutonium, and thorium,

acquire a coating with pyrolytic carbon and/or SiC which is obtained from decomposing hydrocarbons or silanes. Four diagrams illustrate the constructive measures which are to prevent the coating gas from mixing with the inert gas, but this is caused to surround the former.

24672 Nuclear fuel rod. Holzer, R.; Schlemmer, F.; Kroepfl, H.; Lettau, H. (to Siemens AG). German(FRG) Patent 2,019,662/B/. 19 Feb 1976. 3p. (In German).

4 figs. Available from Dt. Patentamt, Muenchen (FRG).

Long nuclear fuel rods are subject to high stress at high temperatures. To cope with such influence, it is suggested to provide a fission gas plenum provided with a supporting sleeve at the end of the enclosing tube and to arrange deformation disks between the nuclear fuel pellets at regular intervals. Various designs of such disks are shown.

24673 Nuclear reactor fuel rod. Ferrari, H.M. (to Westinghouse Electric Corp.). German(FRG) Patent 1,930,033/B/. 20 May 1976. 4p. (In German).

2 figs. Available from Dt. Patentamt, Muenchen (FRG).

The claim relates to a fuel rod consisting of a pressure-tight cladding tube closed on both sides and filled with pellets and provided with increased inner pressure already during the manufacturing process. Within the envelope tube, but outside the fuel space, spaces are formed by transverse walls or cylindrical capsules with a lower inner pressure than the fuel space and having desired rupture spots, responding when a predetermined limit pressure in the fuel space is exceeded. The desired rupture spots of the empty spaces can be set according to step-by-step increasing pressure limits of the fuel space.

24674 Nuclear fuel element with large negative temperature coefficient of reactivity. Miss, R.W. German(FRG) Patent 2,245,113/C/. 16 Jun 1976. 3p. (In German).

2 figs. Available from Dt. Patentamt, Muenchen (FRG).

The claim relates to a fuel element containing in its inner zone a solid fuel and a solid moderating substance of high hydrogen concentration, whereby the inner zone is separated from the surrounding coolant by a heat-insulating layer and by a shell, impermeable to fission products. The heat-insulating layer is an enamel layer burnt into the shell or a ceramic coat, and is arranged on the outside of the shell.

24675 Fuel element for gas-cooled nuclear reactors. Peehs, M.; Huenner, M. (to Kraftwerk Union, A.G.). German(FRG) Patent 2,423,501/B/. 29 Jul 1976. 3p. (In German).

7 figs. Available from Dt. Patentamt, Muenchen (FRG).

The claim relates to the layout and construction of spacers for fixation of a multiplicity of fuel elements equipped with metallic cladding tubes. The spacers consist of a grid of tin straps arranged on edge, the meshes of which contain solid shafts extending axially for centering the fuel elements. These shafts are in contact either with the cladding tube surface or laterally with shafts arranged on this surface. The shafts fastened to the grid are provided with contact areas roughened or having grooves running essentially vertically to the fuel element axis.

24676 Method of producing nuclear fuel rods containing plutonium. Stoll, W. (to Alpha Chemie und Metallurgie G.m.b.H. (ALKEM)). German(FRG) Patent 2,137,133/C/. 29 Jul 1976. 4p. (In German).

1 fig.

The invention concerns a method of producing nuclear fuel rods containing plutonium for thermal nuclear reactors, where the plutonium is only located in the cylindrical periphery zone of the nuclear fuel filling consisting of a uranium compound encased in a shell tube. In the production of the fuel rod, the inner wall of the shell tube is first coated with a layer of matrix containing plutonium. Then the shell tube is filled with the fuel containing uranium and sealed with end caps in the known manner.

24677 Quantitative model for fission gas release and swelling in irradiated uranium dioxide. Hargreaves, R.; Collins, D.A. (UKAEA Reactor Group, Sellafield). *J. Br. Nucl. Energy Soc.;* **15**: No. 4, 311-318(Oct 1976).

A model has been developed to describe the behaviour of fission product gases in irradiated UO_2. The structural changes which occur in UO_2 during irradiation, namely grain growth, swelling and creep, are combined with a theory of fission gas behaviour to enable quantitative predictions of fission gas release and fuel dimensional changes to be made. Examples of the application of the model in computer codes are described.

24678 Calculation on the in-pile diffusional release of fission products forming a general decay chain. Friskney, C.A.; Speight, M.V. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). *J. Nucl. Mater.;* **62**: No. 1, 89-94(Oct 1976).

The effect of precursors on the diffusional release of fission products has been calculated and the specific case of cesium examined in detail. Significantly increased fractional release of an isotope occurs when its rate of diffusion is slow relative to its precursors, particularly when these have half-lives comparable with the irradiation time. Under steady state conditions the release rate of a radioactive isotope depends on the balance between its rates of diffusion and decay, but the form of this dependence is influenced by precursors.

CONTROL SYSTEMS

REFER ALSO TO CITATION(S) 24851

24679 (EPRI-NP—309-SY) Human factors review of nuclear power plant control room design. Summary report. Seminara, J.L.; Gonzalez, W.R.; Parsons, S.O. (Lockheed Missiles and Space Co., Sunnyvale, Calif. (USA)). Nov 1976. 37p. Dep. NTIS $4.00.

Human factors engineering is an interdisciplinary specialty concerned with influencing the design of equipment systems, facilities, and operational environments to promote safe, efficient, and reliable operator performance. The human factors aspects of five representative nuclear power plant control rooms were evaluated using such methods as a checklist-guided observation system, structured interviews with operators and trainers, direct observations of operator behavior, task analyses and procedure evaluation, and historical error analyses. The human factors aspects of design practices are illustrated, and many improvements in current practices are suggested. The study recommends that a detailed set of applicable human factors standards be developed to stimulate a uniform and systematic concern for human factors in design considerations.

24680 Boiling water reactor. Knoedler, D.; Irion, L. (to Siemens AG). German(FRG) Patent 2,310,080/A/. 29 Aug 1974. 11p. (In German).

5 figs.

In the BWR with water separators in the steam space, the control rods are inserted from above into the core. The drive units for this are arranged outside the pressure vessel and provided with guide tubes running through the steam space which are structurally combined with the water separators. Each guide has several absorber elements. Below each guide, a hydraulic shock absorber is mounted, the cooling water serving as hydraulic liquid. Within the guideways the control rods showing a cruciform profile or designed as rod cluster elements are guided by webs or rails in such a manner that they engage correctly into the gap between the fuel elements. The structural connection with the steam space may be achieved by means of a standpipe embracing the rails at this position.

24681 Nuclear power plant. Kostrzewa, S.; Mueller, E.; Vogt, F. (to Internationale Atomreaktorbau G.m.b.H. (INTERATOM)). German(FRG) Patent 2,308,882/A/. 5 Sep 1974. 9p. (In German).

3 figs.

The core of the compact reactor consists of only one fuel assembly. Control is achieved by rod cluster absorber elements, single parallel groups of which are connected with a common drive mechanism by means of spiders. In order to be able to shut down the reactor safety on failure of single drive unit and to control it uniformely in azimuthal and variably in radial direction, the groups are distributed on narrow bands. It is possible, in particular, to choose an arrangement on parts of concentric circumferences, on semicircles connected with each other in H-shape, on homologous concentric semicircles, and on nearly complete circles with alternatingly variable diameter. The spiders of the groups belonging to different control drives are labyrinthinely inserted into one another.

24682 Absorber rod for nuclear reactors with spherical shaped fuel elements. Schweiger, F. (to Hochtemperatur-Kernkraftwerk G.m.b.H. (HKG)). German(FRG) Patent 2,112,472/C/. 31 Oct 1974. 4p. (In German).

1 fig.

The absorber rod is moved into the pebble bed by means of a drive mechanism. On its circumference it has a multiple thread with a greater pitch in the area of the free top than in the rest of the threaded part. According to the course of thread, the absorber rod is rotated clockwise or counterclockwise if pushed into the pebble bed. The spherical fuel elemets resting against the absorber rod are thus pushed aside by the thread. At the same time, the fuel elements move upwards, thus reducing the mechanical stressing of the spheres.

24683 Rapid neutron flux monitoring system for pulsed reactors. Iida, T.; Sumita, K. (Osaka Univ., Suita (Japan). Faculty of Engineering); Wakayama, Naoaki. pp 205-223 of In Proceedings for the symposium on intense pulsed neutron sources in Japan. Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1975).

From Symposium on intense pulsed neutron sources in Japan; Tokai, Ibaraki, Japan (13 Mar 1975).

Investigations on design principles of rapid and stable neutron flux monitoring systems for pulsed reactors are described, including picoammeter, logarithmic amplifier and neutron current chamber. In

order to get rapid response, the method of compensating the capacitance of signal cables and stray feedback circuits is adapted to picoammeters and logarithmic amplifiers by considering the stability margin of whole amplifiers. The response of ionization current chambers are discussed the method of compensating the ion component of chamber output with a high pass filter is suggested. Statistical fluctuations of current chamber output are also discussed. The results of measurements by the fast pulsed reactor "YAYOI" with instruments using those principles are reported.

24684 Control-rod actuating mechanism for nuclear reactors. Deweese, J.L. (to Westinghouse Electric Corp.). French Patent 2,273,347/A/. 17 Jan 1975. 15p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 18 Jan 1974, US.

The invention relates to a control-rod actuating mechanism for nuclear reactors, designed for handling a transfer rod to which is fastened a control-rod. The mechanism compises magnetically actuated hooks for moving a transfer-rod, and a electrically actuated means for locking said hook at its locking position on the transfer-rod, said electrically actuated means being maintained in its position whenever the electric current feeding same is cut-off. This can be applied to nuclear reactors for keeping the control-rods out of the core whenever the reactor-vessel is opened.

24685 Coolant flow control system for nuclear power plants. Pfister, K. (to Siemens AG). German(FRG) Patent 1,932,904/C/. 23 Jan 1975. 3p. (In German).

1 fig.

The probe monitors the temperature of the coolant in power plants and its reaching a certain flow velocity. It comprises a temperature feeler with a plastic body, the front side of which is cross-flowed by coolant. A spirally designed heating coil is provided as a jacket conductor flatly arranged on the cup-shaped front side. The cup edges are of such a height with respect to the cup bottom that the coolant will start to stagnate when the flow becomes slow. A vapour film is formed on the heat exchanger surface and the heat transfer is strongly deteriorated immediately. The test element is a hot conductor (semiconductor resistor), which is applied to the cup bottom. An embedding mass of cured resin with aluminium powder provides for good heat transfer. A plurality of cups rather than a single one may alternatively be provided. These cups form a honeycomb type structure with no notable heat transfer occurring in the recesses when the coolant flow is slow or has come to a standstill.

24686 Coupling device for hollow pulling element of nuclear reactor. Maslenok, B.A.; Chegai, A.S.; Zlobin, V.G.; Mednickii, V.G.; Genkin, L.I.; Gluskov, A.T. Czech Patent 157,175. 15 Feb 1975. 7p. (In Czech).

A device is proposed for connecting the hollow pull-rod of the control rod drive in a nuclear reactor with the regulating rod. It is highly reliable in operation, is easily operated and allows for the interchange of drives on the reactor lid.

24687 Device for driving nuclear reactor control rod. Louda, J. Czech Patent 157,481. 15 Apr 1975. 4p. (In Czech).

A device is proposed for the nuclear reactor control rod drive consisting of a kinematic pair formed by a rack and a pinion. The device makes possible the design of a unified nuclear reactor control having the regulating, compensating, and scram functions in a single block with a minimum cross section.

24688 Study on qualification of domestic instrumentation and control equipment for PWR plant. Asai, T.; Iguchi, T. (Mitsubishi Heavy Industries Ltd., Kobe (Japan). Kobe Shipbuilding and Engine Works); Morimoto, H.; Kuwabara, K.; Takeuchi, Y. *Mitsubishi Juko Giho;* **12**: No. 6, 740-747(Nov 1975). (In Japanese).

Strict functional and reliability requirements are imposed on the instrumentation and control equipment for PWR nuclear power generating plant for the establishment of nuclear safety. Presented is the summary of reliability analysis and various qualification testings of the domestic products adopted for process instrumentation and control, mainly for reactor control, protection and safeguard systems of PWR plants. The results indicate the presently adopted domestic instrumentation and control equipments and systems satisfy the requirements and are evaluated nearly equivalent to the imported products.

24689 Method of changing the concentration of boric acid in the coolant of nuclear reactors, and equipment to carry out this method. van der Schoot, M.R. (to Westinghouse Elctric Corp.). German(FRG) Patent 2,120,177/B/. 15 Jan 1976. 5p. (In German).

4 figs Available from Dt. Patentamt, Muenchen (FRG).

Method of changing the concentration of boric acid in the coolant of nuclear reactors, the coolant being conducted over an ion exchanger and being cooled for releasing boric acid to the ion exchanger, whereas it is warmed for accepting boric acid from the ion exchanger. The method is characterized in thatthe coolant is conducted repeatedly over the ion exchanger and, in doing so, is cooled and warmed alternately before entering the ion exchanger.

24690 System for reactivity control in nuclear reactors. Kollmar, W. (to Kraftwerk Union A.G.). German(FRG) Patent 2,434,226/A/. 5 Feb 1976. 7p. (In German).

2 figs. Addition to P2159196.8 Available from Dt. Patentamt, Muenchen (FRG).

The invention, which is an addition to patent application 2159196.8 relating to a device for reactivity control in nuclear reactors by means of changes of concentration of a more or less neutron-absorbing liquid, proposes to pass this liquid (e.g. boric-acid solution) through the control-rod guide tubes so that no additional vessels have to be applied and excessive liquid quantities do not become necessary. The guide tubes of several fuel elements may advantageously be interconnected by means of a circular pipeline.

24691 Drive for the control unit of a nuclear reactor. Maslenok, B.A.; Slobin, W.G.; Chegaj, A.S.; Nikolajew, W.P.; Krjuger, E.A. German(FRG) Patent 2,221,002/C/. 19 Feb 1976. 2p. (In German).

2 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention relates to an improvement of a device for driving a control element of a nuclear reactor with the aim of making this structure simple and compact with a small cross-section dimension. The device has a rack connected with the control element and a conversion gear actuated by an electric motor. A drive pinion mounted on a rotatable arm is pivotable between a position not meshing with the rack and an engaging position fixed by a solenoid. According to the invention, electric motor and solenoid are mounted coaxially with the rack, and the axially displaceable core of the electric magnet is connected with the arm by a hinged rod.

24692 Actuating drive for the absorber rods of a nuclear reactor. Acher, H. (to Kraftwerk Union A.G.). German(FRG) Patent 2,442,722/A/. 25 Mar 1976. 19p. (In German).

8 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention relates to an improvement of the actuating drive of a boiling-water reactor, which is equipped with a spindle and a movable nut accommodating travelling rolls with mesh with threads in the spindle. To enable high relative velocities between spindle and movable nut and hence a very rapid motion of the absorber rods (e.g. for rapid shutdown of the nuclear reactor), it is suggested to arrange the axes of the travelling rolls at right anlges with the spindle and to combine at least three travelling rolls by means of low-friction bearing bodies. Further structural details which help to improve safe handling are described.

24693 Nuclear reactor. Irion, L.; Kollmar, W. (to Kraftwerk Union A.G.). German(FRG) Patent 2,460,250/A/. 24 Jun 1976. 15p. (In German).

5 figs. Available from Dt. Patentamt, Muenchen (FRG).

The arrangement of a boric-acid-fed shutdown system in a pressurized-water reactor is introduced. The boric acid containers are directly on the pressure vessel closure. The distributor system above the reactor core is shown.

24694 Safety insert for absorber rods. Schweiger, F. (to Hochtemperatur-Kernkraftwerk G.m.b.H. (HKG)). German(FRG) Patent 2,112,471/B/. 29 Jul 1976. 3p. (In German).

1 fig. Available from Dt. Patentamt, Muenchen (FRG).

An absorber rod for gas-cooled reactors with spherical fuel elements is described which can be drawn from the core even in the broken state. This is achieved by a safety insert attached to both ends of the rod securing the mechanical joint of both parts in case the rod breaks apart.

24695 Control of nuclear reactors. Mueller, E.; Roegler, H.J.; Wickert, M. (to Internationale Atomreaktorbau G.m.b.H. (INTERATOM)). German(FRG) Patent 2,456,019/A/. 12 Aug 1976. 19p. (In German).

7 figs. Available from Dt. Patentamt, Muenchen (FRG).

A LWR reactor for propulsion is described; for control purposes it has a movable absorber system with adjustable rods in addition to a fixed system of burnable neutron poisons. The neutron poisons are concentrated on the side of the core looking away from the control rods.

24696 Neutron noise as an information carrier for the early detection of rod malfunction. Antonopoulos-Domis, M. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). *J. Inst. Nucl. Eng.;* **17**: No. 5, 115-117(Sep 1976).

It is stated that noise analysis for reactor malfunction diagnosis can, in principle, identify malfunctioning and provide early warning with virtually no interference with the normal operation of a reactor. This paper is concerned with the possible use of neutron noise for the early detection of control rod malfunctioning. Progressing damage changing the geometrical configuration or the mass distribution of the rod supports will be manifest by a frequency shift of the peaks in the neutron power spectral density, and the location of the peaks can be used to identify the condition of the rods. Two cases of rod malfunctioning are studied -(1) a simply supported beam with a worn bearing, and (2) a case of rattling occurring at the pad.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 25336

24697 (ANL/EIS—6) **Evaluation of environmental data relating to selected nuclear power plant sites. Prairie Island Nuclear Generating Plant site.** Murarka, I.P. (Argonne National Lab., Ill. (USA)). Nov 1976. Contract W-31-109-ENG-38. 114p. Dep. NTIS $5.50.

Environmental monitoring data for 1973 through 1975 pertaining to the Prairie Island Nuclear Generating Station (which began commercial operation in December 1973) were analyzed by the most practical qualitative and quantitative methods. Evaluations of aquatic and terrestrial biotic data are presented in this report. The data indicate no significant immediate deleterious effects on the biota from plant operation, thus confirming preoperational predictions. Although the station has not operated long enough to reveal long-term deleterious effects, present indications do not lead to a concerned prediction that any are developing. Recommendations are suggested for improving monitoring techniques.

24698 (BNWL-B—458-2) **Hanford Nuclear Energy Center: an interim conceptual study.** (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Nov 1976. Contract EY-76-C-06-1830. 53p. Dep. NTIS $4.50.

A conceptual layout of a Hanford Nuclear Energy Center comprised of 20 and 40 reactors with associated fuel cycle facilities has been developed based on limited technical studies. During the past year these studies have emphasized meteorological effects and heat sink management aspects of an HNEC, station electric power, and socioeconomic impacts. The studies to date have not revealed any insurmountable technical or socioeconomic problems, but areas of major uncertainty continue to relate to: (1) Changes in meteorological conditions caused by large heat releases, particularly those related to fog/humidity, rain/hail, ice, and wind generation. (2) Devising a heat sink management plan which results in an acceptable balance among environmental effects, economics, and resource (land, air, and water) utilization compared to dispersed siting. Of the four meteorological aspects which must be analyzed—changes in fog/humidity, rain/hail, ice, and wind—only the fog/humidity aspect has been investigated for an HNEC. (Adequate analytical tools and supporting data for the others are not presently available.) This work indicates that extensive use of cooling ponds and mechanical draft towers will be unacceptable because of increased ground-level fog and/or decreased visibility (though criteria are not available to judge this with certainty). Once-through cooling (to the extent it can be used) and tall mechanical draft towers appear to alleviate the ground-level fog situation. The cloud cover aspects of tall towers have not been examined. Dry or wet/dry cooling systems would probably be acceptable from both ground level fog and cloud cover aspects, but such systems would increase power generation costs 1-2 mills/kW-hr.

24699 **Nuclear power plants and the environment.** Schikarski, W. *Kommunalwirtschaft;* No. 5, 159-162(1975). (In German).

5 tabs.; 6 refs.

Until 1985, a period for which the energy programme of the Federal government was set up, the effects the energy transformation and consumption in the FRG has on the environment are foreseeable and on the average they can be prognosticated. The threat to the environment from polluting agents emitted by single nuclear power plants is very small in comparison with the natural radiation exposure and with the radiation exposure from other energy carriers. The problem of waste heat will not be a limiting factor for energy technology within the next few years if an optimal application of the known recooling techniques for power stations ('Kuehlregie') materializes.

24700 **Nuclear issue as seen by an uncommitted nation.** Doderlein, J.M. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). pp 19-20 of In Nuclear power and the public interest - the implication for business. London; Financial Times (1976).

From Nuclear power and the public interest - the implication for business; London, UK (8 Jul 1976).

Short note.

24701 **Comparison of environmental effects of conventional and nuclear power plants.** Hladky, E. (Vyzkumny Ustav Energeticky, Jaslovske Bohunice (Czechoslovakia)). *Energetika;* **26**: No. 5, 213-217(May 1976). (In Czech).

The relations are defined permitting the comparison of the effects of conventional and nuclear power plants on the living environment on the basis of the amount of annually discharged emissions. The function of relative damage of the living environment (mainly of population) is determined from the maximum calculated values of emission concentrations.

SITING

REFER ALSO TO CITATION(S) 25309

24702 (NP—21425) **Study of existing energy usage on Long Island and the impact of energy conservation, solar energy, total energy, and wind systems on future requirements.** (Dubin-Mindell-Bloome Associates, New York (USA)). 31 Oct 1975. 222p. TIC.

In 1974, the Long Island Lighting Company (LILCO) submitted an application requesting permission to construct two new nuclear power plants at LILCO's Jamesport site in Suffolk County, New York. LILCO's current plans call for completion of Jamesport Unit 1 in 1982, with Jamesport Unit 2 in operation by 1984. At the present time, LILCO is constructing a 820-MW nuclear-powered plant at its Shoreham site in the town of Brookhaven, about twelve miles west of the proposed Jamesport reactors. The initiation of the study is a direct response by Suffolk County to explore two fundamental questions: (1) Will additional central-generating capacity, totaling 2300 MW be needed on Long Island from 1982 and 1984 after the Shoreham plant is built, as LILCO has concluded. (2) Even if energy requirements were to grow beyond LILCO's installed and firm capacity after Shoreham is built, is the construction of additional nuclear-powered central-generating plants the only practical way to provide for future needs, as LILCO has also concluded. To answer these basic questions, the Suffolk County Department of Environmental Control commissioned Dubin-Mindell-Bloome Associates, P.C., in February of 1975 to assess the energy forecast upon which LILCO has based its planning for future facilities, and to prepare alternative estimates of electrical power requirements for 1975 to 1995. In addition, DMBA was commissioned to identify and quantify the potential reduction in peak loads and savings in annual electrical energy consumption by alternative means of meeting future requirements—other than by the construction of new nuclear central generating plants, or other than systems which if substituted for nuclear power plants, would simply result in the consumption of more fossil fuels. The results of the assessment are presented.

24703 **Some observations using meteorological balloons at the Kyoto University Reactor site.** Mizuma, M. (Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst.). *Annu. Rep. Res. Reactor Inst., Kyoto Univ.;* **8**: 60-68(Oct 1975).

Some observations were carried out using constant volume balloons, free, and captive balloons carrying a special type of radiosonde in warm periods of 1973 and 1974 at the Kyoto University Reactor site. Significant results obtained are as follows: (1) Trajectories of constant volume balloon meander significantly both horizontally and vertically over hilly terrain in the daytime, dissimilar to streamline flow along topographic profiles. (2) Air layer of almost neutral stability observed in the lowest few hundred meters of the atmosphere in the daytime becomes shallower in the afternoon than in the morning, over which air layer having subadiabatic lapse rate exists. (3) Well-defined inversion is observed in the lowest few tens of meters layer, which grows more marked with southerly surface wind. These results may give some of basic data to the diffusion climatological research for the site.

24704 **Biblis: Cause with too much impact.** Resch, I. *Energie;* **28**: No. 8, 219-220(Aug 1976). (In German).

1 fig.

Taking the Biblis reactor as an example, the author weighs the advantages and the necessity of energy production against the risk. It would be desirable to convey an idea of the load capacity of such a plant and of its components' precision to the layman and to journalists critical of nuclear energy.

RADIOACTIVE EFFLUENTS

24705 (LA-NUREG—6570-MS) **LEAF: a computer program to calculate fission product release from a reactor containment building for arbitrary radioactive decay chains.** Lee, C.E.; Apperson, C.E. Jr.; Foley, J.E. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1976. Contract W-7405-ENG-36. 40p. Dep. NTIS $4.00.

The report describes an analytic containment building model that is used for calculating the leakage into the environment of each isotope of an arbitrary radioactive decay chain. The model accounts for the source, the buildup, the decay, the cleanup, and the leakage of isotopes that are gas-borne inside the containment building.

CHEMICAL AND THERMAL EFFLUENTS

24706 (ANL/WR—76-5) **Water resources research program. Thermal plumes from submerged discharges at Zion Nuclear Power Station: prototype measurements and comparisons with model predictions.** Paddock, R.A.; Frigo, A.A.; Van Loon, L.S. (Argonne National Lab., Ill. (USA)). Jul 1976. Contract W-31-109-ENG-38. 173p. Dep. NTIS $7.50.

Several field surveys of thermal plumes from the two submerged discharges at the Zion plant were carried out during 1975.

The survey results are presented in the form of horizontal isotherm maps at vertical intervals of 0.5 m from the surface to a depth of 3.0 m. Selected vertical cross sections are also presented. It was found that the direction of the ambient lake current, with respect to the initial discharge direction, can have a significant effect on initial dilution as well as subsequent plume size. The plumes from the two outfalls were found to interact significantly, resulting in the double-discharge plume being more than ten times as large as the sum of two separate single-discharge plumes. The results of the field measurements are compared with several analytical model predictions and with the results of preoperational physical-model studies. The surface isotherm areas are also compared with data collected at several surface-discharge sites. Compared with the surface discharges, the submerged discharge at the Zion plant produces larger initial surface dilutions and much smaller high-temperature isotherm areas. The differences, however, become less striking after the excess temperature has dropped to about 20 percent of its initial value.

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

REFER ALSO TO CITATION(S) 24683, 24703, 24740, 24741, 24813, 25560

24707 (HEDL-TC—533) **CLIRA hydraulic design verification test. FFTF development testing. Final test report.** Seay, J.M.; Lauby, W.J. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jan 1976. Contract EY-76-C-4-2170. 46p. AT.

Satisfactory performance of the Closed Loop In-Reactor Assembly (CLIRA) at Closed Loop System flow rates for the one year design life is a necessary requirement for operation in the Fast Flux Test Facility. The report discusses the results of a two month hydraulic flow test (water) on the CLIRA Prototype. Results of vibration, pressure drop, and flow rate needed for optimum design of fuel test experiments are presented. The results demonstrated satisfactory performance of the CLIRA at prototypic Closed Loop System flow rates.

24708 (HEDL-TI—76049) **Covered pressure drop flow test/ crossflow mixing test.** (Hanford Engineering Development Lab., Richland, Wash. (USA)). [nd]. Contract EY-76-C-14-2170. 19p. AT.

Preliminary results from the pressure drop flow test conducted as part of the crossflow mixing test in FFTF fuel assemblies are presented.

24709 (LMEC—76-4) **FFTF HTS/DHX prototype module testing in SCTI. Final report.** Frangos, A.Z. (Liquid Metal Engineering Center, Canoga Park, Calif. (USA)). 30 Oct 1976. Contract E(04-3)-0700. vp. AT.

This report covers testing of the full-size prototype module Heat Transfer System/Dump Heat Exchanger (HTS/DHX), one of twelve units to be installed for the Fast Flux Test Facility (FFTF) at Hanford, Washington. The overall objectives of the HTS/DHX test program at Liquid Metal Engineering Center (LMEC) were to demonstrate steady-state and transient performance of the full-sized prototype module in a sodium loop under simulated FFTF process conditions and to verify DHX installation, startup, and maintenance procedures. Steady-state testing indicated a deficiency in the thermal performance. A two-phase program was completed to increase performance to design requirements. Installation of baffles to reduce bypass airflow (Phase I) produced a significant improvement in thermal performance. Installation of an ASME orifice meter (Phase II testing) gave a more reliable sodium flow measurement. The design modifications to the air side of the HTS/DHX tubes (Phase II "Lufkin" tapes) did not achieve the design objective. The final approach to the design fix is presently under study by HEDL.

24710 (ORNL/TM—5777) **High Flux Isotope Reactor quarterly report, July, August, and September of 1976.** Corbett, B.L.; McCord, R.V. (Oak Ridge National Lab., Tenn. (USA)). Jan 1977. Contract W-7405-ENG-26. 18p. Dep. NTIS $3.50.

An extended shutdown to replace part of the beryllium reflector reduced the operating time for the quarter to 88 percent and the operating time for the year to 92.9 percent. The semiannual reactor component inspection was completed and the control plates were changed. Basic operating data for the quarter are listed.

24711 (TREE-NUREG—1024) **Computer reactivity requirement and control rod worth for 30 MW, 2-day operation of PBF with a large reactive experiment.** Nigg, D.W.; Scott, A.J. (EG and G Idaho, Inc., Idaho Falls (USA)). Sep 1976. Contract EY-76-C-07-1570. 131p. Dep. NTIS $6.00.

Reactor physics calculations have been performed to investigate the feasibility of conducting loss of coolant (LOCA) experiments that will require steady state operation with the present Power Burst Facility (PBF) reactor core configuration. It was determined that sufficient excess reactivity would be available for 48 hour irradiation of a 16-pin LOCA test cluster at a PBF core power of 30 MW. It was also determined that shutdown requirements could be met with the LOCA test in place and that no additional reactivity shimming would be necessary. A description of these calculations is given.

24712 Statistical techniques for the identification of reactor component structural vibrations. Kemeny, L.G. (New South Wales Univ., Kensington (Australia). School of Nuclear Engineering). pp 13p, Paper F1/4 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The identification, on-line and in near real-time, of the vibration frequencies, modes and amplitudes of selected key reactor structural components and the visual monitoring of these phenomena by nuclear power plant operating staff will serve to further the safety and control philosophy of nuclear systems and lead to design optimisation. The School of Nuclear Engineering has developed a data acquisition system for vibration detection and identification. The system is interfaced with the HIFAR research reactor of the Australian Atomic Energy Commission. The reactor serves to simulate noise and vibrational phenomena which might be pertinent in power reactor situations. The data acquisition system consists of a small computer interfaced with a digital correlator and a Fourier transform unit. An incremental tape recorder is utilised as a backing store and as a means of communication with other computers. A small analogue computer and an analogue statistical analyzer can be used in the pre and post computational analysis of signals which are received from neutron and gamma detectors, thermocouples, accelerometers, hydrophones and strain gauges. Investigations carried out to date include a study of the role of local and global pressure fields due to turbulence in coolant flow and pump impeller induced perturbations on (a) control absorbers, (B) fuel element and (c) coolant external circuit and core tank structure component vibrations.

24713 Analytical and experimental study of two concentric cylinders coupled by a fluid gap. Mulcahy, T.M.; Turula, P.; Chung, H.; Jendrzejczyk, J.A. (Argonne National Lab., Ill. (USA)). pp 9p, Paper F2/7 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

A breeder reactor vessel is a substantial steel cylinder which is partially protected from the nuclear reaction temperature by a 'thermal liner' - a relatively thin concentric shell separated from the vessel by a narrow fluid-filled gap. This paper describes an experimental and analytical study of the vibration of a model of such a shell used in the U.S. Atomic Energy Commission's Fast Test Reactor. The analytical work consists of two parts, the first uses a free vibration solution of the shell in vacuum as a basis for extrapolating vibration behavior for the same shell with a fluid gap. The second part consists of a direct finite element solution of the actual problem - the shell and the fluid coupling it to the rigid outer container. The experimental setup consisted of a steel sheet rolled and welded into a cylinder, free at the top edge and at the bottom soldered to a disc which in turn was bolted to a heavy base plate. This setup was intended to provide a fixed condition at the bottom of the cylinder. The fluid gap was provided by using a thick concrete shell as the outer cylinder. A series of these cylinders was used to provide several sizes of annular gap. The case of the steel shell alone, without fluid, was also considered. The steel cylinder was vibrated by an electromagnetic exciter using both harmonic loading and random loading functions. This exciter was mounted on a relatively rigid support on the inside of the cylinder, near the top edge of the shell. In general, correspondence of experimental and analytical results is within acceptable limits.

24714 Experimental and theoretical vibration analysis by noise measurements of a sodium cooled reactor. Bauernfeind, V.; Olma, B.J. (Technische Univ. Muenchen, Garching (Germany, F.R.). Lab. fuer Reaktorregelung und Anlagensicherung). pp F1/3 1-13 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Studies of mechanical vibrations of primary components and their correlations with pressure and neutron flux at the compact sodium cooled reactor KNK (20 MWe), Karlsruhe, gave substantial information of the movement of the reactor vessel and its internals. Displacement measurements and noise measurements of pressure and neutron flux were performed in the power range of 27%-100%. The maximum of the power spectral densities together with the observed natural frequencies of reactor components were investigated. By calculating the power spectral densities with different filter bandwidths deterministic and stochastic parts of the spectra were separat-

ed. The most powerful peaks in the spectra were flow-induced stochastic spectra parts as well as two deterministic lines, excited mechanically by the pumps. Some of these maxima could also be observed by correlating them with the noise of pressure and neutron flux. By means of a model the influence of the process dynamics on the power density spectra of the measured variables was checked. The comparison of power spectral densities and coherences of mechanical vibrations of the vessel at different power levels showed natural frequencies down to 25 cps. Phases of cross power spectral densities revealed a combined horizontal and vertical movement of the reactor vessel. The impact of a free falling control rod was successfully used as a mechanical excitation of the system. The measurements showed natural frequencies of various reactor internals (e.g. core support, shock shield). Tests with variable pump speed gave information on global mechanical characteristics of the reactor system.

24715 Dynamics and control of Repetitive-Accelerator Fast-Pulsed Reactor. Wakabayashi, J.; Hoshino, T.; Yoshikawa, H.; Harada, S. pp 229-260 of In Proceedings for the symposium on intense pulsed neutron sources in Japan. Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1975).

From Symposium on intense pulsed neutron sources in Japan; Tokai, Ibaraki, Japan (13 Mar 1975).

The preliminary design study of the Repetitive-Accelerator Fast-Pulsed Reactor (AFPR) is promoted by the technical research committee on pulsed reactors. As a part of above mentioned project, the authors studied the dynamics and control of AFPR analytically, and proposed the matrix iterative technique. This technique is very useful for the calculations of steady state characteristics and power excursion phenomena of AFPR. It can also serve in examining the possible methods of controlling the AFPR.

24716 Nuclear instrumentation for P-YAYOI. Akiyama, M.; Saito, I.; Wakabayashi, H.; An, S. (Tokyo Univ. (Japan). Nuclear Engineering Research Lab.). pp 157-175 of In Proceedings for the symposium on intense pulsed neutron sources in Japan. Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1975).

From Symposium on intense pulsed neutron sources in Japan; Tokai, Ibaraki, Japan (13 Mar 1975).

The nuclear instruments equipped to the reactor P-Yayoi are described. Taking reliability into consideration, the systems of compensated ionization chamber (CIC) with fast DC amplifiers and plastic scintillator with a photomultiplier are chosen as the nuclear instruments for P-Yayoi. The DC amplifiers and current-to-voltage converter with detector power supply are to be located in the reactor room. The output signals from the DC amplifiers and the current-to-voltage converter are sent to the reactor control room through coaxial, low noise cables. The two out of three signals of two CIC's and a scintillator are analyzed by a wave form calculator. The main features of the CIC are as follows. The sensitivity to thermal neutrons is 4.4×10^{-14} amp/nV, the covering thermal neutron flux range is from 10^2 to 10^{10} nV, and the uncompensated gamma sensitivity is 3×10^{-11} amp/R/hr. The measured rise time of the DC amplifier is 12 μsec. The measured linearity of the converting factor is considered to be satisfactory for the P-Yayoi. Signal recording systems consist of a wave form calculator and oscilloscopes with cameras. The wave form calculator has two channels of AD and DA converters, memories, interface and calculating function. Input signal is analyzed by these AD converters and stored in the memory. The four characteristic values, peak power, reactor period, FWHM and integrated power, are obtained for stored pulses. The relative detector efficiency to the reactor power of CIC channels is measured for the purpose of selecting counter positions.

24717 Burst shape measurements and design of monitor device for P-YAYOI. Sakamoto, S. (Tokai Univ., Tokyo (Japan). Faculty of Engineering). pp 177-190 of In Proceedings for the symposium on intense pulsed neutron sources in Japan. Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1975).

From Symposium on intense pulsed neutron sources in Japan; Tokai, Ibaraki, Japan (13 Mar 1975).

Nonstationary operation is feasible at the Fast Neutron Source Reactor of Tokyo University "YAYOI". In this connection, this paper describes preliminary results of power observations by use of micro fission counters and a current integral type scintillation detector, and the design of a burst shape monitor device. The fission counter is practical and effective in measuring burst shapes below the prompt critical state but becomes useless above the prompt critical state. On the contrary, the current integral type scintillation detector is powerful as a nuclear instrumention system for single shot burst operations.

24718 New concept of reactivity pulse operation of fast neutron source reactor YAYOI. Saito, I.; Wakabayashi, H.; Furuhashi, A.; An, S.; Tamura, T. (Tokyo Univ. (Japan). Nuclear Engineering Research Lab.). pp 131-156 of In Proceedings for the symposium on intense pulsed neutron sources in Japan. Tokai, Ibaraki, Japan; Tokyo Univ. Nuclear Engineering Research Lab. (1975).

From Symposium on intense pulsed neutron sources in Japan; Tokai, Ibaraki, Japan (13 Mar 1975).

The fast neutron source reactor YAYOI is to be pulsed by reactivity insertion over the prompt critical state by employing two pile oscillators at one time. The unique idea of fly-through type reactivity insertion, core design features, operational limitations, calculated properties for typical operational conditions and considerations about preservation of core integrity are described.

24719 (EURFNR—1316) Measurement of the energy distribution of the gamma field in a fast reactor. Horn, H.E. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (Germany, F.R.)). Nov 1975. Translation of KFK—2211. 82p. Dep. NTIS $5.00.

Work performed under United States—Euratom Fast Reactor Exchange Program.

Si(Li) semiconductor detectors were used to measure the energy distribution of the gamma field in the Karlsruhe fast zero-power facility SNEAK with the help of the Compton electron spectrum registered with the detectors. The method was checked by comparing measured γ-attenuation coefficients of different materials with the values known from literature. The spectra of two assemblies (one with uranium, the other with plutonium fuel) with compositions similar to fast sodium cooled breeder reactors were measured in the core and in the blanket. In addition the γ-spectrum in a lithium sphere induced by 14 MeV neutrons was determined.

24720 Fast flux test facility (FFTF) fuel-pin non-destructive assay measurements. Goris, P.; DeMerschman, A.W. (Hanford Engineering Development Lab., Richland, Wash. (USA)). pp 599-610 of In Safeguarding nuclear materials. Vol. 2. Vienna; IAEA (1976).

From Symposium on the safeguarding of nuclear materials; Vienna, Austria (20 Oct 1975).

The Hanford Engineering Development Laboratory (HEDL) is evaluating utilization of a ^{252}Cf fuel-pin scanner as a non-destructive assay technique to determine shipper-receiver assays of fissile materials in liquid-metal fast-breeder reactor-type fuel pins. All fast flux test facility (FFTF) fuel pins produced for cores 1 and 2 are being assayed with the fuel scanner. Results have been compared with chemical measurements. In a set of 49 pins, using six scans per pin, no significant differences were observed between non-destructive assay and chemical assay on six randomly selected pellets from each fue pin after it had been destructed. Shipper-receiver differences for outer core fuel pins under HEDL calibration of the fuel-pin scanner agree with chemical shipper-receiver differences within experimental limitations. Quality control data over a two-year period involving 1286 observations for seven fuel-pin standards indicate a long-term random error of 0.84% relative standard deviation per single fuel-pin assay. A random variation of S=0.84% per single fuel-pin assay has little or no effect on the uncertainty in toal Pusub(f) in statistically large numbers of fuel pins. Long-term agreement with given quality control fuel pins ranges form -0.23% to +0.12%. The overal weighted averaged agreement is -0.10%, which indicates an apparent bias trend for the fuel-pin scanner under the present two-point calibration technique. In a large number of fuel pins composing a shipment, the uncertainty for total fissile plutonium, as determined by the fuel-pin scanner, is due to the uncertainty of assay of the fuel-pin standards.

24721 Cooling-time determination of the nuclear fuel for a VVR-S reactor. Ursu, I.; Rodean, E.; Farcasiu, O.M.; Ionescu, V.; Dumitrescu, R.; Stanescu, P.S.; Rosescu, T.; Deberth, C. (Institutul de Fizica Atomica, Bucharest (Romania)). pp 633-640 of In Safeguarding nuclear materials. Vol. 2. Vienna; IAEA (1976).

From Symposium on the safeguarding of nuclear materials; Vienna, Austria (20 Oct 1975).

The cooling time for exposed nuclear fuel in a light-water-moderated research reactor of 10% enriched fuel was studied for 30 EK-10-type fuel assemblies. For this purpose, the scanning of the fuel assemblies was done with a mobile mechanical device and a Ge(Li) detector coupled to a multichannel analyser. The fuel assemblies were immersed under a 3-m-thick layer of water, and the measurements were performed at various angles. The systematic experiments indicated that the immersion angle makes an important contribution to the quality of the results. The optimum value of this angle was also established. The experimental results show that many fission-product isotopes can be used for the cooling-time determination; in report the optimum choice of these isotopes for this type of reactor is given. It was also found that the total time interval can be divided into a few subgroups, each of which has an equation of a specific analytical form. The use of the combined experimental results and of theoretical calculation allows cooling times, which agree well with the real values, to be predicted.

24722 Rapid calculation code for predicting characteristics of fast experimental reactor 'JOYO'. Suzuki, M. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). *Toshiba Rebyu;* **31**: No. 1, 49-51(Jan 1976). (In Japanese).

A rapid calculation code system, SMART, has been developed for the fast experimental reactor "JOYO". The code system,

being a subsystem of the off-line computation system for supervising the operation of "JOYO," can predict the reactor characteristics during cycle operation, such as control rod worth, burn-up characteristics of fuel, sodium outlet temperature, clad and fuel maximum temperature, and evaluates the safety of the scheduled operation. It can also be used to make records of the reactor characteristics, such as fuel burn-up, accumulated neutron exposure, clad and fuel temperature after the cycle operation. Typical machine time is about 8 minutes on the TOSBAC-5600/170.

24723 Promulgation of the agreement on the accession of the Government of the United Kingdom of Great Britain and Northern Ireland to the German-French agreement of 19th January, 1967 on the construction and operation of a high flux reactor in the by the Additional Agreement of 6th July 1971 amended version. *Bundesgesetzblatt, Teil 2;* No. 9, 244(Feb 1976). (In German).

Short communication only.

24724 Some study on radiation resistance and reliability of piston rings of waste gas compressor for fast breeder experimental reactor. Muramatsu, T.; Hidaka, T. (Ebara Mfg. Co. Ltd., Tokyo (Japan)). *Ehara Jiho;* No. 95, 41-44(Mar 1976). (In Japanese).

In the fast breeder experimental reactor "Joyo", the gaseous wastes such as reactor cover argon, reactor seal nitrogen gas, fuel handling waste gas, etc. will be collected, compressed and stored for activity decay. Compressors applied in the above process have new type oilless piston rings of Teflon filled with graphite, which might be affected by radioactivity of the waste gases. This report deals with some study on the gamma iradiation effects on the plastic piston rings such as tensile strength, elongation, shock and hardness effects under several irradiation doses and on durability test of the irradiated piston rings under the same compression ratio.

24725 Possibilities of utilizing esearch reactors for treating dynamic and control problems in power reactors. Bouzyk, J.; Gadomski, A.; Latek, S. (Institute of Nuclear Rresearch, Warsaw (Poland)). *Kernenergie;* **19**: No. 6, 183-188(Jun 1976). (In Russian).

The possibilities of utilizing research reactors for solving some problems associated with nuclear energy programs, in particular dynamic and control problems, are analysed. Examples of works carried out in a research reactor of WWR-SM type are given.

24726 Tritium survey of pool-type research reactors. Plappert, R.; McKlveen, J.W. (College of Engineering Science, Tempe, Arizona (USA)). *Health Phys.;* **31**: No. 2, 169-170(Aug 1976).

The result of a survey of existing tritium concentrations in fifteen research pool-type reactors in the USA is given showing direct correlation between the maximum rated power and the concentration and the pool size and the concentration.

PLUTONIUM AND ISOTOPE PRODUCTION REACTORS

REFER ALSO TO CITATION(S) 24747

PROPULSION REACTORS

REFER ALSO TO CITATION(S) 24695

24727 Study on the thermohydraulic characteristics of marine nuclear reactors, II. Critical heat flux of Freon-113 flowing in an annulus. Otsuji, T.; Hanabata, S.; Kurosawa, A. (Kobe Univ. of Mercantile Marine (Japan)). *Kobe Shosen Daigaku Kiyo. Dai-2-rui. Kokai, Kikan, Rigaku-hen;* No. 23, 87-93(Oct 1975). (In Japanese).

Experimental critical heat flux data were obtained with Freon-113 in an annular geometry. Range of system pressure was 2 to 3 kg/cm^2 abs, mass flux 1.65 to $6.5x10^6 kg/m^2$. hr and inlet subcooling 0.9 to 35°C. At low mass flux, experimental results agreed with the values predicted by means of Ahmad's correlation within +-20%. However, at high mass flux, the difference between the experimental and predicted values became relatively large.

24728 Neutron physics analysis of thermionic reactors with U 233 as fuel and ZrHsub(1,7) as moderator. Sahin, S. (Ege Universitesi, Izmir (Turkey). Muehendislik Bilimleri Fakueltesi). *Atomkernenergie;* **28**: No. 4, 256-258(1976).

3 figs.; 2 tabs.; 20 refs.

Thermionic reactors with U 233 as fuel and ZrHsub(1,7) as moderator are appropriate as primary or secondary energy sources in space craft. In this paper, neutron physics analysis of such a reactor is presented. All neutron physics calculations have been carried out with the help of multigroup Ssub(n) methods. 123 energy groups, S_4-P_3 approximation for one-dimensional and 4 energy groups, S_4-P_1 approximation for two-dimensional calculations have been used. Some integral values and neutron production densities are given as characteristic properties of the reactor.

NUCLEAR SHIPS LICENSING AND REGULATION

24729 Nuclear law and law of the sea; a synthesis. Courteix, S. (Centre National de la Recherche Scientifique, 75 - Paris (France)). pp 71-82 of In Nuclear Inter Jura 75 Proceedings. Paris; International Nuclear Law Association (1976). (In French)

From Nuclear Inter Jura 75 Congress; Aix-en-Provence, France (29 Sep 1975).

The general idea behind the work of the Paris Colloqium on Nuclear Law and Law of the Sea was that of an agreement and sometimes opposition between two specificities, that of the law of the maritime and, in particular, ocean environment, and that of the law of nuclear techniques. These relationships were studied notably in the perspective of the problems of transport of nuclear materials and their liability insurance, as well as from the viewpoint of the operation of nuclear powered ships. Another problem studied in this context is that of radioactive marine pollution.

REACTOR SAFETY

REFER ALSO TO CITATION(S) 25723

24730 (ANL—76-84) **Parametric effects of varied channel pressure drop on the molten-cladding motion.** Chen, W.L.; Ishii, M.; Grolmes, M.A. (Argonne National Lab., Ill. (USA)). Jul 1976. Contract W-31-109-ENG-38. 31p. AT.

A one-dimensional cladding-relocation model was applied to L- and R-series test conditions in which the pin bundles were small. The results were consistent with the experimental observation and with SAS calculations. One of the key assumptions of this model was that the total pressure drop over the voided channel could be supplied as a boundary condition for the vapor-momentum equation. The parametric study of the total pressure drop was carefully performed for the FFTF-type subassembly, and the oscillatory pressure effect due to the streaming sodium vapor generated by the chugging of the lower level of liquid sodium was also investigated. There is an axial blanket region in CRBR or commercial-power-plant designs instead of a reflector in FFTF design above the top of fuel. A significant difference exists in the thermal conductivities between the blanket and reflector, which could delay the timings of all events of the cladding relocation for the CRBR design case. The fuel may begin to lose its geometry, and the molten fuel might spill out when the molten cladding is still around. Consequently, the vapor production due to steel boiling might provide the early vapor source for fuel dispersal.

24731 (BN-TOP—4(Rev.0)) **Subcompartment pressure and temperature transient analysis.** Braddy, R.W.; Thiesing, J.W. (Bechtel Corp., San Francisco, Calif. (USA)). Jul 1976. vp. Bechtel Power Corp., San Francisco, CA.

The analytical techniques used to predict pressure and temperature histories in subcompartments following postulated pipe breaks are described. The multiple compartment computer code, COPDA, is described in detail along with criteria for subcompartment modeling.

24732 (BNL—21917) **Distribution of burst pressure for tubes.** Kao, C.S. (Brookhaven National Lab., Upton, N.Y. (USA)). Oct 1976. Contract EY-76-C-02-0016. 14p. (CONF-761023—3). Dep. NTIS $3.50.

From 2. ERDA statistical symposium; Oak Ridge, Tennessee, United States of America (USA) (25 Oct 1976).

In a nuclear reactor, tubes are pressurized from interior by coolant, while externally no pressure is applied on them. The pressure that causes any of the tubes to burst is random and has certain distribution. By using the presently available data from stress-strain experiment, mathematical procedure for finding the distribution form of the ultimate stress is made and is justified theoretically and empirically. The distribution function obtained is important in analyzing the problem of loss of coolant in the reactor.

24733 (BNL-NUREG—22140) **TEMperature Pressure ESTimation of a homogeneous boiling fuel-steel mixture in an LMFBR core.** Pyun, J.J.; Majumdar, D. (Brookhaven National Lab., Upton, N.Y. (USA)). 1 Nov 1976. Contract EY-76-C-02-0016. 89p. Dep. NTIS $5.00.

The paper describes TEMPEST, a simple computer program for the temperature and pressure estimation of a boiling fuel-steel pool in an LMFBR core. The time scale of interest of this program is large, of the order of ten seconds. Further, the vigorous boiling in the pool will generate a large contact, and hence a large heat transfer between fuel and steel. The pool is assumed to be a uniform mixture of fuel and steel, and consequently vapor production is also assumed to be uniform throughout the pool. The pool is allowed to

expand in volume if there is steel melting at the walls. In this program, the total mass of liquid and vapor fuel is always kept constant, but the total steel mass in the pool may change by steel wall melting. Because of a lack of clear understanding of the physical phenomena associated with the progression of a fuel-steel mixture at high temperature, various input options have been built-in to enable one to perform parametric studies. For example, the heat transfer from the pool to the surrounding steel structure may be controlled by input values for the heat transfer coefficients, or, the heat transfer may be calculated by a correlation obtained from the literature. Similarly, condensation of vapor on the top wall can be specified by input values of the condensation coefficient; the program can otherwise calculate condensation according to the non-equilibrium model predictions. Meltthrough rates of the surrounding steel walls can be specified by a fixed melt-rate or can be determined by a fraction of the heat loss that goes to steel-melting. The melted steel is raised to the pool temperature before it is joined with the pool material. Several applications of this program to various fuel-steel pools in the FFTF and the CRBR cores are discussed.

24734 (BNWL—2143) **Thermal performance experiments on ultimate heat sinks, spray ponds, and cooling ponds.** Hadlock, R.K. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Dec 1976. Contract EY-76-C-06-1830. 86p. Dep. NTIS $5.00.

A program of measurement on a Battelle-Northwest (BNW) spray pond has been completed to prove an integrated instrumentation system for application in future field experiments. The measurement programs in the field will produce data of relevance to the design and understanding of performance for ultimate heat sinks as components of emergency core cooling systems. In the absence of active emergency cooling systems, the data will be obtained on analog systems--prime candidates among these are the naturally-occurring hot ponds at Yellowstone National Park and man-made hot cooling ponds at Savannah River National Laboratory as well as spray ponds at various industrial facilities. The proof experiment has provided data that not only illustrate the effectiveness of the instrumentation system but also display interesting site-specific heat transfer processes. The data to be obtained in the field will also be site specific but must be of generic applicability in modeling for design and performance purposes. The integrated instrumentation system will evolve, through modest modifications and substantial supplementation, to provide the requisite data for the more demanding situation of work in and about hot water.

24735 (CENPD—168(Rev.1)) **Design basis pipe breaks for the Combustion Engineering two loop reactor coolant system.** (Combustion Engineering, Inc., Windsor, Conn. (USA)). Sep 1976. vp. Combustion Engineering, Inc., Windsor, CT.

The report describes the criteria and analytical methods used to establish the design basis for the mechanical effects of postulated pipe breaks in the C-E two-loop reactor coolant system piping. This report was originally submitted in August of 1975, and response to NRC request for additional information was provided in Supplement 1, November, 1975. Revision 1 incorporates the information provided in Supplement 1 in the main body of the text, and additionally provides updated basic criteria and detailed results. Methods and results are presented for the determination of the most likely break locations throughout the piping system, the most likely break type (circumferential severance or longitudinal slot) at each assumed break location, and break characteristics such as orientation, size, and break opening time. The criteria for locating and defining the various breaks are sufficiently conservative to provide a high level of protection against pipe whip, jet impingement, subcompartment pressurization, and component loadings from a significant number of pipe breaks in addition to the specific postulated pipe breaks.

24736 (COO—2781-5) **Fuel coolant thermal interaction project. Quarterly progress report No. 4, April 1, 1976—June 31, 1976 .** (Massachusetts Inst. of Tech., Cambridge (USA)). 1976. Contract EY-76-S-02-2781. 28p. Dep. NTIS $4.00.

The objective of the project reported is to experimentally and analytically study the dominant mechanisms in fuel coolant thermal interactions which could lead to vapor explosions. Exploration of mechanisms is focused in two areas: (1) mechanisms responsible for fragmentation in molten metal droplet experiments (including the proposed Spontaneous Nucleation Mechanism), and (2) thermal stress initiated fracture as a fragmentation mechanism (this mechanism is not considered responsible for the fragmentation of molten metal drops).

24737 (EGG—1183-1670) **Structure shielding from cloud and fallout gamma ray sources for assessing the consequences of reactor accidents.** Burson, Z.G.; Profio, A.E. (EG and G, Inc., Las Vegas, Nev. (USA)). Dec 1975. Contract E(29-1)-1183. 44p. Dep. NTIS $4.00.

Radiation shielding provided by transportation vehicles and structures typical of where people live and work were estimated for cloud and fallout gamma-ray sources resulting from a hypothetical reactor accident. Dose reduction factors are recommended for a variety of situations for realistically assessing the consequences of reactor accidents.

24738 (EPRI-NP—275) **Separated flow model of two-phase flow. Interim report.** Wallis, G.B.; Richter, H.J.; Kuo, J.T. (Dartmouth Coll., Hanover, N.H. (USA). Thayer School of Engineering). Dec 1976. 142p. Dep. NTIS $6.00.

The report describes the present status of work in progress at Dartmouth College on the separated flow model of two-phase flow. It contains a review of the general framework of equations and emphasizes the need for evaluating the usefulness of this formulation when it is applied to relatively simple flow regimes. The applications chosen for testing the theory are: flashing, including critical flow, and flow of bubbles, suspended in water, through nozzles. The first topic is being studied using published data; several forms of the "interaction terms" are being investigated. The second topic is being studied by gathering data on bubble trajectories and comparing these with predictions. Preliminary results and plans for further experiments are described.

24739 (GA-A—13734) **Status of post-accident fuel containment studies for a 300-MW(e) GCFR demonstration plant.** Menzel, H.F.; Kang, G.S. (General Atomic Co., San Diego, Calif. (USA)). [nd]. Contract E(04-3)-0167-PRJ-23. Ap. (CONF-751140—4). Dep. NTIS $3.50.

From Meeting on post-accident heat removal information exchange; Albuquerque, New Mexico, USA (13 Nov 1975).

Studies have been underway for several years at General Atomic to assess the capability of the prestressed concrete reactor vessel to contain molten core debris. Analytical techniques have been developed and are being improved. Results of preliminary studies for a 300-MW(e) GCFR demonstration plant indicate that both heat removal downward, through the internal graphite and steel shielding, and upward, primarily by radiation to other shielding, are important. Sensitivity analyses, performed to scope the range of uncertainties in phenomena and materials properties, seem to confirm that critical temperatures are rather insensitive to changes in input parameters. Experiments have been defined that are needed to elucidate and verify thermodynamic processes occurring in the debris, as well as its interactions with shielding and structural materials.

24740 (HEDL-ARD-FS—257(Rev.1)) **HCDA requirements and loadings for FFTF design evaluation. Revision 1.** (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jul 1976. Contract E(45-1)-2170. 650p. AT.

This document presents requirements, loadings, and evaluations for the Fast Flux Test Facility (FFTF) in the event of a Hypothetical Core Disruptive Accident (HCDA) which releases up to 150 MW-sec of available work energy. This HCDA is postulated to provide assurance of adequate safety margins in the containment design for the third level of safety. Detailed loads resulting from the HCDA and the evaluation of consequences to components, systems, and structures essential to the containment of the accident are provided. Hence, this document serves as a project control document in which all relevant information concerning the impact of the HCDA on the FFTF is presented. This document is provided in support of the FFTF FSAR.

24741 (HEDL-SA—877) **Nastran nonlinear dynamic transient accident analysis for FFTF reactor component.** Lujan, R.A.; Chenault, D.M.; Go, J.C. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1976. Contract EY-77-C-14-2170. 9p. (CONF-761103—24). Dep. NTIS $3.50.

From ANS winter meeting; Washington, District of Columbia, United States of America (USA) (15 Nov 1976).

A nonlinear dynamic transient analysis merging hand calculations and the NASTRAN structural analysis computer code was conducted for a Fast Flux Test Facility in-reactor test assembly during an extremely unlikely design basis accidental event which is considered a Hypothetical Core Disruptive Accident (HCDA). The finite element modeling of the problem took advantage of NASTRAN's versatility to create loads and nonlinear elements not previously found in NASTRAN's library. The structural criteria for the test assembly to withstand an HCDA stipulates that the test assembly and its spoolpiece shall remain integral with the reactor head such that missiles are not generated.

24742 (HEDL-SA—1117) **Water and gas release from heated concrete.** McCormack, J.D.; Postma, A.K. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1976. Contract E(45-1)-2170. 31p. (CONF-760941—1). Dep. NTIS $4.00.

From NRC safety technology meeting on inherent retention; Washington, District of Columbia, United States of America (USA) (21 Sep 1976).

A program is currently underway with the objective to develop a mathematical model for predicting water and gas release from heated concrete. The heating conditions of interest are those associated with postulated accidents in LMFBR plants. The scope of

the program includes development of a mechanistic model of moisture and gas transport in heated concrete, experimental measurements on concrete to provide needed transport coefficients, and overall substantiation of the model. Work completed to date indicates that the dominant mechanism for water and gas transport in heated concrete is a pressure-driven flow of fluid through concrete pores. Water may exist as vapor, as liquid, and as a sorbed phase. All three forms, and interchange between the three forms, must be recognized in a satisfactory model. Finite difference equations have been written for a model in which water moves between concrete nodes as a result of pressure and concentration gradients. The computer solution of these equations is presently being debugged. Scouting tests have demonstrated that water release rates from heated concrete are limited by mass transfer resistance, and that the type of aggregate has little influence on the release rate. An apparatus was assembled to measure adsorption isotherms for hardened cement paste at elevated temperatures. Initial results indicate that most of the evaporable water sorbed at 100 percent relative humidity results from capillary condensation. Experimental equipment has been built to measure the permeability of concrete to fluid flow. Results obtained demonstrated a steep increase in permeability with increasing temperature. Proof tests of water and gas release from sizable concrete specimens have been designed to evaluate the predictive model.

24743 (HEDL-SA—1120) **Experimental plans for LMFBR cavity liner sodium spill test LT-1.** Hilliard, R.K.; Newell, G.A. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1976. Contract E(45-1)-2170. 17p. (CONF-760941—2). Dep. NTIS $3.50.

From NRC safety technology meeting on inherent retention; Washington, District of Columbia, United States of America (USA) (21 Sep 1976).

Reinforced concrete is an important material of construction in LMFBR cavities and cells. Steel liners are often installed on the concrete surfaces to provide a gastight seal for minimizing air inleakage to inerted cell atmospheres and to protect the concrete from direct contact with sodium in the event of a sodium spill. In making safety assessment analyses, it is of interest to determine the adequacy of the liners to maintain their leaktightness during postulated accidents involving large sodium spills. However, data for basing analytical assessments of cell liners are very meager and an experimental program is underway at HEDL to provide some of the needed information. The HEDL cell liner evaluation program consists of both bench-scale feature tests and large-scale sodium spill demonstration tests. The plans for the first large-scale sodium spill test (LT-1) are the subject of this paper.

24744 (HEDL-TC—537) **LMFBR source term iodine attenuation test of bubble breakup/coalescence in LMFBR outlet plenum following large fission gas release.** Dickinson, D.R.; Nunamaker, F.H. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Dec 1975. Contract EY-76-C-14-2170. 42p. Dep. NTIS $4.00.

Tests were performed with water in a 0.51-scale model to determine the bubble sizes and degree of contact of liquid and gas in the CRBR outlet plenum following a hypothetical large sudden release of fission gas from the fuel. The test assembly modeled the tops of six fuel subassemblies surrounding a control rod, the chimney above these, and the free space in the outlet plenum up to the suppressor plate. A known volume of gas was introduced rapidly by opening a valve from a pressurized storage reservoir. Test parameters studied were liquid flow rate (modeling 0, 10 and 50 percent CRBR flow); number of fuel subassemblies with gas release (1 and 6); volume of gas released (modeling 40 and 100 percent of end-of-life gas inventory); and speed of gas release (less than 1 sec and 8 sec). Data were obtained by direct visual observation and by high-speed color motion pictures.

24745 (HEDL-TC—653) **COBRA-III/MELT: a computer code for analyzing thermal-hydraulic behavior in large LMFBR pin bundles.** Yung, S.C. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Oct 1976. Contract EY-76-C-14-2170. 55p. AT.

A description is given of the digital computer program COBRA-III/MELT. This program is a modified version of the HEDL COBRA-III M code, and is intended to be used in conjunction with the LMFBR safety analysis code, MELT-III. The COBRA-III/MELT code incorporates the following modifications: (1) the fuel pin description has been made compatible with the MELT-III code in that axially-dependent fuel restructuring can be taken into account; (2) since HEDL's version of the COBRA-III M code was designed for analyzing 7-pin bundles in the TREAT facility, it needed to be modified to a suitable size in order to analyze FFTF fuel subassemblies; and (3) a metrication conversion subroutine has been added for compatibility with MELT-III because the latter code is in SI units. Program input instructions and sample problem are provided to illustrate the features of COBRA-III/MELT.

24746 (HEDL-TC—730) **Experimental study of hydrogen formation and recombination under postulated LMFBR accident conditions.** Wierman, R.W.; Hilliard, R.K. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1 Dec 1976. Contract EY-76-C-14-2170. 58p. Dep. NTIS $4.50.

The report describes an experimental study of hydrogen jets burning in air, hydrogen formation by sodium in humid air atmospheres, and the effects of nitrogen, water vapor sodium vapor/aerosol, jet velocity, and jet temperature on ignition of hydrogen jets. The results show that hydrogen jets above 1450°F (788°C) issuing into an air atmosphere need no ignition source for ignition, a hydrogen jet temperature higher than 500°F (260°C) and containing more than six grams of sodium per cubic meter of jet gas will autoignite in an air atmosphere, the burning efficiency of a hydrogen jet decreases rapidly to zero when the oxygen concentration outside the flame region approaches 10 percent, and hydrogen does not form from a sodium-nitrogen jet issuing into a humid air atmosphere until the ratio $O_2/(H_2O + O_2)$ is less than 0.5.

24747 (HW—74094(Vol.3)) **Hazards summary report. Volume 3. Description of the 100-B, 100-C, 100-D, 100-DR, 100-F, and 100-H Production Reactor Plants.** (General Electric Co., Richland, Wash. (USA). Hanford Atomic Products Operation). 1 Apr 1963. Contract E(45-1)-1350. 210p. Dep. NTIS $7.75.

The purpose of the report is to present a comprehensive physical description of the 100-B, 100-C, 100-D, 100-DR, 100-F and 100-H Production Reactor Plants at Hanford. This volume is part of an over-all Hazards Summary Report, and complements Volumes 1 and 2. The term "Production Reactor Plant" is defined as a Hanford Production Reactor plus its associated water supply and effluent water disposal facilities.

24748 (LA-NUREG—6447-PR) **Reactor safety and technology. Quarterly progress report, April 1—June 30, 1976.** Lathrop, K.D. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Jul 1976. Contract W-7405-ENG-36. 87p. Dep. NTIS $5.00.

Reactor safety studies involving HTGR, LWR, and LMFBR type reactors are reported. (DG)

24749 (NEDO—20355A) **Effect of a large bundle flow area restriction on the BWR emergency core cooling system effectiveness.** Leonard, J.E.; Duncan, J.D. (General Electric Co., San Jose, Calif. (USA). Boiling Water Reactor Systems Dept.). Aug 1976. vp. General Electric Corp., San Jose, CA.

A full-scale, Zircaloy-clad, simulated BWR fuel Bundle was tested under simulated loss-of-coolant conditions. The flow area at the bundle midplane was severely restricted by mechanical means so the effect of an exaggerated flow blockage on emergency core cooling effectiveness could be determined. Because of the mechanical conditions imposed on this bundle a region of systematic, concentrated bowing developed below the blockage during the experiment. This artificially imposed condition is unique to this test bundle and is not representative of a BWR fuel bundle under postulated LOCA conditions. The extent of the flow area restriction, the temperature response, and the oxidation of the bundle cladding in both the blocked and bowed region are described and discussed. It is shown that the presence of a high degree of blockage does not adversely affect emergency core cooling effectiveness above or below the blockage. It is also shown that the systematic, concentrated rod bowing imposed in this test can lead to a predictable degradation of heat transfer in the region of maximum bowing.

24750 (NUREG—0083(Suppl.1)) **Supplement to the safety evaluation report by the Office of Nuclear Reactor Regulation, U. S. Nuclear Regulatory Commission for U. S. Energy Research and Development Administration Light Water Breeder Reactor. Project No. 561.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Nuclear Reactor Regulation). Nov 1976. 7p. Dep. NTIS $3.50.

An evaluation of ECCS performance for a loss-of-coolant accident in the Shippingport LWBR is presented. The application of the FLASH-6 code to LOCA analysis in the LWBR is also discussed.

24751 (ORNL/NUREG/NSIC—129) **LMFBR safety. 2. Review of current issues and bibliography of literature, 1970—1972.** Buchanan, J.R.; Keilholtz, G.W. (Oak Ridge National Lab., Tenn. (USA)). 22 Nov 1976. Contract W-7405-ENG-26;NRC-INA-40-551-75;NRC-INA-40-552-75. 542p. Dep. NTIS $13.00.

This report discusses the current status of liquid-metal fast breeder reactor (LMFBR) development and one of the principal safety issues, a hypothetical core-disruptive accident (HCDA). Bibliographic information on worldwide LMFBRs relative to the development of the breeder reactor as a safe source of nuclear power is presented for the period 1970 through 1972. The bibliography consists of approximately 1620 abstracts covering early research and development and operating experiences leading up to the present design practices that are necessary for the licensing of breeder reactors. Key-word, author, and permuted-title indexes are included for completeness.

24752 (ORNL/NUREG/TM—46) **Blowdown heat transfer separate-effects program. Quarterly progress report, April—June 1976.**

Thomas, D.G.; Baucum, W.E.; Bohanan, R.E. (Oak Ridge National Lab., Tenn. (USA)). 24 Nov 1976. Contract W-7405-ENG-26;NRC-INA-40-495-75. 125p. Dep. NTIS $5.50.

Progress is reported in the areas of program planning and administration, two-phase flow instrumentation, forced convection test facility (FCTF) operation, bundle hydraulics, analysis, thermal-hydraulic test facility (THTF) operation, THTF instrumentation, and bundle component and fuel rod simulation procurement and development.

24753 (ORNL/NUREG/TM—65) **Fission product beta and gamma energy release. Quarterly progress report, July—September 1976.** Dickens, J.K.; Love, T.A.; McConnell, J.W.; Freestone, R.M.; Emery, J.F.; Peelle, R.W. (Oak Ridge National Lab., Tenn. (USA)). 28 Oct 1976. Contract W-7405-ENG-26;NRC-INA-40-551-75;NRC-INA-40-552-75. 33p. Dep. NTIS $4.00.

Gamma-ray energy-release data for thermal-neutron fissioning of ^{235}U were obtained for waiting times 2 less than or equal to t/sub w/ less than or equal to 14000 sec. These data were processed to give modest-resolution gamma-ray energy spectra vs. t/sub w/. The resulting spectra have been integrated to give integral gamma-ray energy-release data. Beta-ray data obtained during the previous quarter were processed to give beta-ray energy spectra for waiting times 2 less than or equal to t/sub w/ less than or equal to 14000 sec. Some of these spectra have been compared with existing data; the quality of agreement varies between poor and very good. The beta-ray spectra have been integrated to give integral beta-ray energy-release data. Total energy-release data were obtained by summing the gamma-ray energy-release data with the beta-ray energy release data. The total energy-release data have been compared (a) with the current ANS Decay Heat Standard, (b) with results of computations using current best files of fission-product data, and (c) with results of other recent experiments. These comparisons suggest likely improvement to the current standard for t/sub w/ less than or equal to 400 sec, as well as reduction of the uncertainties assigned to the standard.

24754 (ORNL/NUREG/TM—74) **Multirod burst test program quarterly progress report for April—June 1976.** Chapman, R.H. (Oak Ridge National Lab., Tenn. (USA)). 3 Jan 1977. Contract W-7405-ENG-26;NRC-INA-40-551-75. 63p. Dep. NTIS $4.50.

The rupture temperature—rupture pressure relationship derived from simulators tested in a steam environment is in general agreement with earlier data obtained by Hobson from tests in argon. However, the rupture strain appears to be significantly lower. Since the Hobson tests employed a different method of heating, the difference in rupture strain may be due to heating method or test environment or to both. Five tests were conducted in an argon environment to explore the effect of these two experimental parameters; these tests were conducted in the range of burst temperatures where oxidation effects would be expected to influence the results. Test conditions were selected for the argon tests to permit direct comparison with earlier steam tests, and in some cases the same fuel simulators were used to obtain even better comparisons. The results of the tests were in qualitative agreement with the Hobson data and other published data. Two additional steam tests were conducted to obtain a better definition of the failure strain in the temperature range 1050°C (1922°F), where earlier data seemed to indicate a sharp maximum. The results from the two tests appear anomalous and internally inconsistent when compared to an earlier comparable test. In one of these tests (SR-13), the observed burst strain was 79 percent [at a burst temperature of 1079°C (1974°F)], which is almost a factor of 2 greater than the 44 percent observed in the earlier test (SR-2) at a burst temperature of 1082°C (1980°F). The observed strain in the second (SR-17) was 53 percent and the burst temperature was 1049°C (1920°F).

24755 (ORNL/NUREG/TM—83) **Monthly highlights for Office of Nuclear Regulatory Research Programs at Oak Ridge National Laboratory, December 1976.** Fee, G.G. (comp.). (Oak Ridge National Lab., Tenn. (USA)). 10 Jan 1977. Contract W-7405-ENG-26;NRC-INA-40-551-75;NRC-INA-40-552-75. 24p. Dep. NTIS $3.50.

Technical highlights are presented for the following safety-related studies: heavy section steel technology, fission product beta and gamma energy release, multirod burst tests, nuclear safety information center, PWR blowdown heat transfer-separate effects, zircaloy fuel cladding collapse studies, zirconium metal-water oxidation kinetics, aerosol release and transport from LMFBR fuel, HTGR safety analysis and research, design criteria for piping and nozzles, and noise diagnostics for safety assessment. (DG)

24756 (TREE-NUREG—1002) **Experiment data report for Semiscale Mod-1 Test S-04-3 (Baseline ECC test).** Crapo, H.S.; Collins, B.L.; Sackett, K.E. (EG and G Idaho, Inc., Idaho Falls (USA)). Oct 1976. Contract EY-76-C-07-1570. 206p. Dep. NTIS $7.75.

Recorded test data are presented for Test S-04-3 of the Semiscale Mod-1 Baseline ECC Test Series. This test is among several Semiscale Mod-1 experiments conducted to investigate the thermal and hydraulic phenomena accompanying a hypothesized loss-of-coolant accident in a pressurized water reactor system. Test S-04-3 was conducted from an initial cold leg fluid temperature of 543°F and an initial pressure of 2,258 psia. A simulated double-ended offset shear cold leg break was used to investigate the system response to a depressurization and reflood transient with lower plenum coolant injection to eliminate the hot wall delay time. System flow was set to achieve a core fluid temperature differential of 66°F at a full core power of 1.6 MW. The flow resistance of the intact loop was based on core area scaling. An electrically heated core with a flat radial power profile was used in the pressure vessel to simulate the effects of a nuclear core. During system depressurization, core power was reduced from the initial level of 1.6 MW to simulate the predicted surface heat flux response of nuclear fuel rods during loss-of-coolant accident. Blowdown to the pressure suppression system was accompanied by simulated emergency core cooling injection into the intact loop, broken loop, and lower plenum.

24757 (TREE-NUREG—1003) **Experiment data report for Semiscale Mod-1 Test S-04-4 (Baseline ECC test).** Crapo, H.S.; Collins, B.L.; Sackett, K.E. (EG and G Idaho, Inc., Idaho Falls (USA)). Oct 1976. Contract EY-76-C-07-1570. 202p. Dep. NTIS $7.75.

Recorded test data are presented for Test S-04-4 of the Semiscale Mod-1 Baseline ECC Test Series. This test is among several Semiscale Mod-1 experiments conducted to investigate the thermal and hydraulic phenomena accompanying a hypothesized loss-of-coolant accident in a pressurized water reactor (PWR) system. Test S-04-4 was conducted from an initial cold leg fluid temperature of 541°F and an initial pressure of 2,263 psia. A simulated double-ended offset shear cold leg break was used to investigate the system response to a depressurization and reflood transient using downcomer volume scaled coolant injection parameters, modified to account for additional coolant injected directly into the lower plenum. In addition, the volume of the lower plenum was reduced from that used in previous tests to more accurately represent the lower plenum of a PWR, based on system volume scaling. System flow was set to achieve a core fluid temperature differential of 66°F at a core power level of 1.52 MW. The flow resistance of the intact loop was based on core area scaling. An electrically heated core with a flat radial power profile was used in the pressure vessel to simulate the effects of a nuclear core. During system depressurization, core power was reduced from the initial level of 1.52 MW in such a manner as to simulate the predicted surface heat flux response of nuclear fuel rods during a loss-of-coolant accident.

24758 (TREE-NUREG—1019) **Loft systems and test description (loss-of-coolant experiments using a core simulator).** Robinson, H.C. (EG and G Idaho, Inc., Idaho Falls (USA)). Nov 1976. Contract EY-76-C-17-1570. 315p. Dep. NTIS $10.00.

This document is intended to provide the necessary background information to interpret the test information from the Loss of Fluid Test (LOFT) Experimental Data Reports for Tests L1-1 through L1-4. The information provided includes a LOFT system description, an instrumentation and brief data system description, and the test descriptions for Tests L1-1 through L1-4.

24759 (WCAP—7817(Suppl.7)) **Seismic testing of electrical and control equipment for low seismic plants.** Vogeding, E.L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Nuclear Energy Systems Div.). Sep 1976. vp. Westinghouse Electric Corp., Pittsburgh, PA.

The report covers seismic testing of the Engineered Safeguards Test Cabinet, Nuclear Instrumentation System Instrument Bus Solatron Line Voltage Regulator, and two models of Vital Instrument Bus Inverters over the range of 1 Hz to 35 Hz. To demonstrate the ability of the above equipment to perform under such earthquake disturbances, each test specimen was subjected to vibration tests which simulated the seismic conditions for the low seismic class of plants. During testing, the equipment was operated and the critical functions monitored to verify proper performance. The results show that there were no electrical irregularities that would leave the plant in an unsafe condition. Tests were conducted on the Engineered Safeguards Test Cabinet in November of 1972, at the Acton Environmental Testing Corp., Acton, Massachusetts, and on the Nuclear Instrumentation System Instrument Bus Solatron Line Voltage Regulator and Vital Instrument Bus Inverters during July and August 1973, at the Westinghouse Astronuclear Laboratory, Large, Pennsylvania.

24760 (WCAP—7821(Suppl.5)) **Seismic testing of electrical and control equipment for high seismic plants.** Vogeding, E.L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Nuclear Energy Systems Div.). Sep 1976. vp. Westinghouse Electric Corp., Pittsburgh, PA.

The report covers seismic testing performed on the Engineered Safeguards Test Cabinet, Nuclear Instrumentation System Instrument Bus Solatron Line Voltage Regulator, and two models of Vital Instrument Bus Inverters over the range of 1 Hz to 35 Hz. To demonstrate its ability to perform under earthquake disturbances, the above equipment was subjected to vibration tests which simulated

the seismic conditions for the high seismic class of plants. During testing, the equipment was operated and critical functions monitored to verify their proper performance. The results show that there were no electrical irregularities that would leave the plant in an unsafe condition. Tests were conducted on the Engineered Safeguards Test Cabinet in November of 1972, at the Acton Environmental Testing Corp., Acton, Massachusetts, and on the Nuclear Instrumentation System Instrument Bus Solatron Line Voltage Regulator and Vital Instrument Bus Inverters during July and August 1973, at the Westinghouse Astronuclear Laboratory, Large, Pennsylvania.

24761 (WCAP—8541) **Seismic and environmental testing of Foxboro transmitters. Topical report.** Kraszewski, R.A.; Miller, R.B. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Nuclear Energy Systems Div.). Jul 1975. vp. Westinghouse Electric Corp., Pittsburgh, PA.

In a nuclear power plant, transmitters which provide the initiating function for reactor trips and safeguards systems actuation must be capable of performing their function during and after an earthquake which might occur at the plant site. In addition, certain of these transmitters must also be capable of providing similar functions during an accident which releases energy in the form of steam and possibly radioactive fission products to the containment atmosphere. To demonstrate the ability of these transmitters to perform per the above requirements, representative transmitters were subjected to tests simulating the above conditions. The transmitters in this report were all tested by the Foxboro Company of Foxboro, Massachusetts, and the results show that the transmitters do remain operable under the conditions specified.

24762 (WCAP—8855) **Westinghouse ECCS: four loop plant (15 x 15) sensitivity studies with upper head fluid temperature at T/sub hot/.** Beck, H.S.; Beczak, P.E.; Tabone, C.J.; Thompson, C.M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Nuclear Energy Systems Div.). Oct 1976. vp. Westinghouse Electric Corp., Pittsburgh, PA.

The report presents the results of analyses performed for a representative four-loop plant with 15 x 15 fuel design which show the effects of increased upper head fluid temperature on calculated ECCS performance during a LOCA. These analyses use the October, 1975 version of the Westinghouse ECCS Evaluation Model.

24763 (WCAP—8865) **Westinghouse ECCS: four loop plant (17 x 17) sensitivity studies with upper head fluid temperature at T/sub hot/.** Beck, H.S.; Kemper, R.M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Nuclear Energy Systems Div.). Oct 1976. vp. Westinghouse Electric Corp., Pittsburgh, PA.

The report presents the results of analyses performed for a representative four-loop plant with 17 x 17 fuel design which show the effects of increased upper head fluid temperature on calculated ECCS performance during a LOCA. These analyses use the October, 1975 version of the Westinghouse ECCS Evaluation Model.

24764 (XN—76-36) **Exxon Nuclear Company WREM-based generic PWR ECCS evaluation model (ENC-WREM-II): 4-loop PWR with ice condenser large break example problem.** (Exxon Nuclear Co., Richland, Wash. (USA)). Aug 1976. 65p. Exxon Nuclear Co., Inc., Richland, WA.

This document is presented as a demonstration of the ENC-WREM-II calculational procedure using a Westinghouse 4-loop PWR with ice condenser containment. The calculational procedures used are in accordance with the ENC PWR evaluation model. The loss-of-coolant accident investigated was a quillotine configuration wi.h each break area equal to the pipe cross-sectional area. The break was assumed to occur in one cold leg or pump discharge pipe (DECLG break). The investigation involved calculations using the following primary ENC/WREM codes: RELAP4-EM/VERSION ENC 22 for blowdown, reflood, and hot channel analysis, TOODEE2/VERSION ENC 13A for hot channel during refill and reflood, RELAP4-EM/FLOOD option of RELAP4-EM/VERSION ENC 22 for core reflood analysis, and ICECON for reflood containment pressure analysis. For blowdown, refill, and reflood analysis Westinghouse containment back pressure data were used. The document includes descriptions of all portions of the loss-of-coolant analysis.

24765 Dynamic response of fast reactor primary containment. Adamik, V. (Power Research Institute, Jaslovske Bohunice, Czechoslovakia). pp 12p, Paper E3/6 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The Czechoslovak approach to fast reactor primary containment problems is described. It is based on the assumption that the safety assessment of the containment requires an analysis of hypothetical accidents. The experimental programme consists of a sequence of tests using models of increasing complexity. The properties of model or reactor material are obtained with the help of Hopkinson-Davies bar apparatus. The theoretical effort is based on the mechanistic approach. In recent years, a series of codes has been developed in the Power Research Institute. This paper describes mainly the CEFRA code which can determine the dynamic response of fast reactor primary containment. Comparison of the CEFRA code with experimental results and some recent improvements in the code are discused. The code system was applied to a 600 MW fast reactor accident analysis and some results of the analysis are reported.

24766 Computational simulation of cladding motion after melting including resolidification processes. Angerer, G. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). pp 10p, Paper C3/6 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

During flow coastdown or reactivity accidents in LWRs the reactor core may reach a condition where the cladding of the fuel pin starts to melt. The following cladding relocation influences reactor reactivity and core thermohydraulics. Plugging of coolant channels, e.g., may reduce dramatically the possibility of post accident heat removal in these channels. For this reason it is highly desirable to simulate and analyze cladding relocation. Due to the complexity of the problem a computer program is required. The code CMOT is an attempt to serve this purpose. Results are presented of code applications to an unprotected flow coastdown accident in a LMFBR. They show that due to the sodium vapor distribution in the voided core, upward flow of molten cladding may occur. This agrees with the observations made in experiments. But if the cladding plugs, the cross-section sodium vapor flow is inhibited and downward motion of additional molten cladding takes place.

24767 Computations of three-dimensional deformations of hexagonal ducts compared with experimental results. Ash, J.E.; Marchertas, A.H. (Argonne National Lab., Ill. (USA)). pp 14p, Paper E1/8 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The liquid metal fast breeder reactor (LMFBR) core structure consists of a matrix of hexagonal subassembly ducts. Safety considerations require that the deformation response of the hexagonal ducts to a postulated local energy release be predictable. Deformation of the structural matrix can interfere with control-rod withdrawal and can cause local reduction in coolant flow passages. For example, a fuel pin cladding failure resulting in fission gas release will create a pressure-pulse loading on the internal walls of a subassembly hexcan duct. This pressure pulse will attenuate as it travels towards the ends of the hexcan with the result that a three-dimensional transient pressure loading is exerted. A three-dimensional, finite-element structural code SADCAT (Structural Analysis for 3-Dimensional Core Assembly Transient) has been developed to compute the hexcan response to such loadings. Computations made with the SADCAT code have been compared with experiments performed for simulated EBR-II and FFTF out-of-pile ducts. Comparisons are also made with computed two-dimensional code results.

24768 Some questions of material inelasticity and failure in the design of concrete structures for nuclear reactors. Bazant, Z.P. (Northwestern Univ., Evanston, Ill. (USA). Dept. of Civil Engineering). pp 11p, Paper H1/1 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Several aspects of inelasticity of concrete which are particularly important for the safety analysis and failure predictions of concrete pressure vessels and containments are analyzed. The new constitutive laws for multiaxial stress, high temperature transients, unstable strain localization and stochastic properties of creep allow improved predictions of failure of nuclear structures.

24769 Comparative evaluation of numerical methods for dynamic structural analysis. Belytschko, T. (Illinois Univ., Chicago (USA)). pp vp, Paper E4/9 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24770 Results of parametric REXCO H (release 2) calculations and their comparison with experimental data. Benuzzi, A.; Fasoli-Stella, P.; Holtbecker, H.; Verzeletti, G. (Commission of the European Communities, Ispra (Italy). Joint Research Centre). pp vp, Paper E3/3 of In Structural mechanics in reactor technology. Vol. 2.

Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

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24771 Calculation of transient, non-linear phenomena in nuclear reactors using the PISCES computer codes. Birnbaum, N.K.; Orphal, D.L. (Physics International Co., San Leandro, Calif. (USA)); Heeschen, U.; Winkler, H. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). pp vp, Paper F2/1 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24772 Pipe whip analysis for nuclear reactor applications. Bisconti, N.; Lazzeri, L.; Strona, P.P. (Societa di Architettura Industriale per gli Impianti di Generazione di Energia, Genova, Italy). pp 10p, Paper F5/5 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

AEC regulatory guides as well as similar regulatory practice in other countries (e.g. Italy) imposes that the consequences of the uncontrolled movement of a pipe after a LOCA accident should be considered. The procedure envisaged by the authors is as follows: Criteria to determine breakage locations based on pressure, stress levels, etc., are available and are briefly discussed; The various possible ways of limiting the damage due to the uncontrolled movement of the pipe are reviewed (damage envelope, restraints, dampers, etc.). If a restraint solution is necessary a computation of the forces resulting in each postulated breakage is performed by means of the GETTO program, which uses the simplified theory due to Moody. A preliminary analysis of the type, location and characteristics of the restraints is performed by means of the same GETTO code which uses a very simple and rough energy balance between the energy due to the jet force and the energy absorbed by the restraints (correction parameters are introduced coming from practice). A final appraisal of the design is performed by means of the FRUSTA code, which entirely simulates the pipe and restraint behaviours during the transitory. Typical examples for some cases are presented and discussed.

24773 Impulse study of the primary circuit of a breeder reactor. Boisserie, J.M.; Le Bourg, P. (Electricite de France, 78 - Chatou. Direction des Etudes et Recherches); Barrau, P. (NERSA, Lyon, France); Lida, M. (Electricite de France, Service T.E.G.A.E.H., Moret-sur-Loing, France). pp 10p, Paper E3/2 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975). (In French)

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Methods for numerical approach of functional spaces associated to Lagrange's equations of mechanical phenomena are very well known. In case of a simple structure like a shell of revolution with multiple connections it is possible to choose a sufficiently simple and reliable shell theory and to approximate the associate Lagrangian function on a convenient linear space. From this point of view Electricite de France has developed a computer code and used it to study the primary sodium containment of a liquid metal cooled fast breeder reactor. This code has the following capabilities: (a) static and dynamic analysis for symmetrical loading and linear and non-linear material properties; (b) static and dynamic analysis for non-symmetric loads and linear material properties; (c) optimum design for static loads; The paper gives an example of application of this code to the analysis of the dynamic response of the external shell of the sodium system. Loading corresponds to a burst of pressure which might be produced in a serious hypothetical accident in which the core is partially destructed. Pressure waves propagate in the different parts of the shell and act through variable masses of sodium. The shell has multiple branches. Structures are represented by variable inertial properties. Most of the calculations have been made in the elastic range. Comparisons with real explosion situations have been made.

24774 Theoretical model with variable masses for the molten fuel-sodium thermal interaction in a nuclear fast reactor. Caldarola, L. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Angewandte Systemanalyse). pp 24p, Paper E1/1 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

In the model proposed in this paper, the reaction has been assumed to occur in two successive phases. In phase A a given number (function of time) of fuel particles comes in intimate contact with a given mass of liquid Na (function of time). The heat transfer process is characterized by very good direct thermal contact between the fuel and the liquid coolant, and by a large contact area due to the small size of the particles. The heat transfer coefficient decreases with time due to the formation of a temperature profile inside the fuel particles. The heated volume of sodium is constrained by the surrounding unheated coolant and by the other materials present in the core. The mechanical constraint is schematized by a sodium column of finite length which is contained in a channel located above the reaction volume. The sudden expansion of the heated volume first produces acoustic waves which travel along the sodium column. Later the sodium column behaves like a piston which is pushed inertially upwards. The pressure rises, reaches a maximum, and then falls as soon as the expansion of the liquid sodium becomes important. At the time which the pressure reaches the saturation point, sodium boiling starts and phase B begins. In phase B the heat transfer process now characterized by a very large contact area, and by a thermal contact between the fuel and the coolant which becomes increasingly worse with time, due to the formation of a sodium vapour layer at the external surface of the fuel fragments. The sodium will boil in a large quantity, and will produce therefore large volume changes. The sodium piston will be further accelerated and its movement will allow the pressure in the reaction volume to decrease.

24775 Response of the primary piping loop to an HCDA. Chang, Y.W.; Moneim, M.T.A.; Wang, C.Y.; Gvildys, J. (Argonne National Lab., Ill. (USA)). pp 14p, Paper F4/7 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The paper describes a method for analyzing the response of the primary piping loop that consists of straight pipes, elbows, and other components connected in series and subject to hypothetical core disruptive accident (HCDA) loads at both ends of the loop. The complete hydrodynamic equations in two-dimensions, that include both the nonlinear convective and viscous dissipation terms are used for the fluid dynamics together with the implicit ICE technique. The external walls of the pipes and components are treated as thin shells in which the analysis accounts for the membrane and bending strength of the wall, elastic-plastic material behaviour, as well as large deformation under the effect of transient loading conditions.

24776 Bounds on dynamic plastic deformation of hexagonal frames. Corradi, L.; Franchi, A. (Politecnico di Milano (Italy)). pp 10p, Paper E2/8 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The response of thin walled subassembly ducts of hexagonal cross section to an internal pulse of arbitrary shape is studied. A typical reactor core configuration consists of an array of such constituents, each containing an array of fuel elements whose failure may expose the duct to an internal pressure pulse, causing permanent deformation that can reach the order of the wall thickness and cause contact between adjacent elements. Recently a number of papers have tackled the problem of estimating the permanent duct deformation, under various simplifying assumptions. The purpose of this study is to consider the possibility of application of bounding techniques developed in the dynamics of elastoplastic structures, which permit to bound from above total or permanent displacement under given dynamic actions, with a computational effort moderate with respect to a step-by-step evolutive dyanamic analysis. The duct is conceived as a hexagonal frame and the effects of interaction between bending and membrane forces is accounted for, both in the plasticity condition and in its geometric consequences.

24777 Modelling techniques for pipe whip analysis. Dini, D. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy). Div. Sicurezza e Controlli); Lazzeri, L. (Societa di Architettura Industriale per gli Impianti di Generazione di Energia, Genova, Italy). pp 10p, Paper F5/6 of In Structural meachnics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The problem of modelling a pipe and its restraining units during the pipe whip accident is discussed; the following main points (which are available in the FRUSTA program) are considered: (a) A complete dynamic model of the pipe is considered only for the part between the postulated rupture and the first elbow, the remaining part is considered only to simulate its stiffness. (b) Both a circumferential (pipe only on one side of the rupture) and a longitudinal (pipe on both the sides of the rupture) breakage can be considered. (c) The pipe mass is lumped in each node (max.20) (d) The pipe stiffness is

simulated by means of a particular element, which can account for the elastic, plastic, ovalization, instability and unloading behaviour of the pipe. (e) The restraint is simulated by a proper element with a bilinear characteristic after a 'no load' phase. (f) A damper can be simulated by means of an element, whose reaction force is proportional to the velocity of the application point. (g) A dummy (fully indefinitely elastic) element can be introduced in order to simulate end conditions, rigid motions, etc. (h) The crushing behaviour of the pipe when hitting a restraining surface can be approximately simulated by introducing a proper restraint, which accounts for the pipe elasticity and reduction of moment capability. (i) A step by step integration procedure is followed: a Gauss-Euler algorithm is used. (j) Maxima of the kinematics, stress and strain characteristics are given.

24778 Structural dynamics in fast reactor accident analysis. Fistedis, S.H. (Argonne National Lab., Ill. (USA)). pp 14p, Paper E3/1 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Since the beginning of Liquid Metal-Cooled Fast Breeder Reactor (LMFBR) development, it has been found desirable to make safety provisions, such as containment, which were over and above systems for reactor control. The effort resulted in systematic development of analyses and codes, and the performance of confirmatory experiments. Gradually, an organized body of knowledge developed in this sector of technology. This paper briefly describes (1) the problems involved in the evaluation of the response of the LMFBR to Hypothetical Core Disruptive Accidents (HCDA), (2) the currently available analytical tools and extent of their confirmation, and (3) the remaining areas of further development needed.

24779 Structural reliability evaluation of a Zr-2 pressure tube in case of LOCA. Garribba, S. (Politecnico di Milano (Italy). Centro Studi Nucleari E. Fermi). pp vp, Paper F8/3 of In Structural mechanics in reactor technology. vol.2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

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24780 Prediction of reactor pressure tube flow transients with effects of friction and heat addition included using a fixed-grid method of characteristics. Goel, M.L. (Atomic Energy of Canada Ltd., Sheridan Park, Ontario. Power Projects); Gorman, D.J. (Ottawa Univ., Ontario (Canada)). pp vp, Paper F1/8 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24781 Limit load analysis of the lateral support framework for an ice condenser system. Grierson, D.E. (Waterloo Univ., Ontario (Canada)); Lapay, W.S. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). pp 10p, Paper F6/5 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The ice condenser is a safeguard system for a nuclear power plant. Its function is to cool the steam released within the containment in the event of a design basis accident, thereby decreasing the pressure acting on the containment structure. The system extends around a 300 degree arc between the inner and outer containments, and is approximately 60 feet in height. Structurally, the ice condenser system consists of slender ice baskets, 48 feet in length, vertically extending through tiered lattice frames to a lower support structure which provides both vertical and horizontal constraint at the base of the baskets. The lattice frames provide lateral support to the ice baskets at six foot vertical intervals. To facilitate installation maintenance, the ice baskets are not attached to the lattice frames but in fact, are separated from them by a slight gap. Limit analysis of the lattice framework is conducted for three principle load conditions: radial, tangential, and radial + tangential. Depending on the load pattern, the analysis is formulated as a linear programming problem based on either the static or kinematic theorem of plastic collapse. In view of the size and complexity of the lattice frame, decomposition theory is employed to reduce the various problems to the smallest size possible. Multiple stress resultants affecting plasticity are considered, and corresponding piecewise linear yield surfaces are generated also using mathematical programming techniques. A general computer programme is employed for all analyses.

24782 Prediction of the pressure-time history due to fuel-sodium interaction in a subassembly. Jacobs, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). pp 9p, Paper E1/3 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

A local cooling disturbance may lead to complete voiding of a subassembly and melt down of the fuel pins. Thus molten fuel may be accumulated and mixed with liquid sodium returning accidentally into the subassembly. The resulting fuel-sodium interaction (FSI) produces a pressure load on the surrounding core structures. It is necessary to prove that the corresponding core deformation neither initiates a nuclear excursion nor renders the shut down system inoperable. This requires the knowledge of the initiating FSI pressure time history. In this paper a theoretical pressure time history is presented which differs completely from all calculations known so far.

24783 Analysis of long duration subassembly accidents. Kennedy, J.M. (Argonne National Lab., Ill. (USA)); Schoeberle, D.F.; Belytschko, T. (Illinois Univ., Chicago (USA)). pp 11p, Paper E2/5 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The evaluation of the safety aspects of the subassembly configuration of liquid metal fast breeder reactors (LMFBR), requires that effective numerical procedures be available for both short and long duration loadings. Some of the postulated accidents are characterized by rapid load variations followed by very steady loads, whereas other accidents are characterized by loads of a quasi-static nature. The existing STRAW (Structural Transient Response of Assembly Wrappers) code includes only explicit integration in time. Hence, the time step is limited to a percentage (50% to 80%) of the highest frequency of the mesh. An implicit integration option has been added to STRAW, rathr than being developed as a separate code, for the following reasons. (1) it permits the same analysis to be performed partially with an explicit temporal integration and partially with an implicit temporal integration in the same computer run, and (2) it permits part of the mesh to be handled with the explicit-part with implicit integration.

24784 Mechanical behavior of the LMFBR core structure under transient pressure due to local failure. Krieg, R.; Liebe, R.; Will, H.; Zehlein, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorentwicklung). pp 11p, Paper E2/1 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

A satisfactory fast reactor safety analysis requires a comprehensive experimental and theoretical research program. The structural integrity of the reactor core in case of any local failure has to be demonstrated. Such local events may be due to random pin failure which is very likely. As a consequence contact between molten fuel and coolant may occur. The existing uncertainties in the understanding of the physical mechanisms observed during this molten fuel-coolant-interaction (MFCI) emphasize the importance of the comprehensiveness of this research program. This paper describes the effort done at GfK Karlsruhe in cooperation with UKAEA and EURATOM to predict the core deformations caused by local failure within an LMFBR core. These activities try to cover all important questions currently discussed in the analysis of possible core damage. It may be concluded that the reactor can be scrammed in time under pessimistic-realistic pressure transients and that the deformations do not exceed tolerable limits. The computer methods are general enough as to allow for different core designs with varying geometries, material properties, etc.

24785 Application of different failure criteria in fuel pin modelling and consequences for overpower transients in LMFBRs. Kuczera, B.; Royl, P. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorentwicklung). pp 17p, Paper C3/5 of In Structural mechanics in reactor technology. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The CAPRI-2 code system for analysis of hypothetical core disruptive accidents in LMFBRs has recently been coupled with the transient deformation model BREDA-2. The new code system determines thermal and mechanical loads under transient conditions for both fresh and irradiated fuel and cladding, taking into account fuel restructuring as well as effects from fission gas and fuel and clad swelling. The system has been used for analysis of mild uncontrolled overpower transients in the SNR-300 to predict failure, and to initialize and calculate subsequent fuel coolant interactions (FCI). Thirteen channels have been coupled by point kinetics for the whole core analysis. Three different failure mechanisms and their influence on accident sequence have been investigated.

24786 Structural response of fast-reactor core subassemblies to thermal loading. Kulak, R.F.; Kennedy, J.M. (Argonne National Lab., Ill. (USA)); Belytschko, T. (Illinois Univ., Chicago (USA)). pp 10p, Paper E1/6 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The structural response of the Liquid Metal Fast Breeder Reactor (LMFBR) hexcan when a high heat flux is applied to the outside of one flat is presented. Results for hexcan displacements and internal stress distributions are presented for both unirradiated and irradiated duct material. A comparison is made between duct wall response as predicted from a plane stress and plain strain two-dimensional analysis and the behaviour as predicted by a three-dimensional analysis. It is found that for a given reference temperature and yield strength there is a limit to the maximum temperature difference through the duct wall which can be tolerated by the heated zone before buckling or wrinkling occurred.

24787 Calandria vessel loading due to a pressure tube rupture in heavy water reactor. Kumar, S.N.; Dixit, K.B. (Department of Atomic Energy, Bombay (India). Power Projects Engineering Div.); Ghosh, A.K. (Bhabha Atomic Research Centre, Bombay (India). Reactor Engineering Div.). pp 11p, Paper F8/1 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Pressure tube rupture accidents are the basis for the design of calandria vessel components in the heavy water pressure tube reactor. The main heavy water coolant at 102kg/cm ^{2} pressure and 260°C temperature flows in the Zircaloy-2 pressure tube which contains fuel bundles. The pressure tube is enclosed by a Zircaloy-2 calandria tube. For safety analysis it is assumed that the calandria tube ruptures simultaneously along with the coolant tube. The high enthalpy coolant flashes into the moderator and thus introduces additional volume in the calandria vessel. Rupture discs are provided at the end of 4 relief pipes connected to the calandria vessel to limit the over-pressure. The problem is analysed in two stages viz. pressurization of calandria vessel due to addition of volume in the form of heavy water vapor bubbles and generation of shock waves due to collapse of these bubbles. The calculations show that the calandria peak pressure is governed by the inertia effect of the moderator in the relief pipe. The effect of bubble condensation is found to be of secondary importance. The post-peak pressure variation however depends upon the bubble condensation.

24788 Nonlinear transient deformation of LMFBR fuel elements under impulsive loading. Liebe, R. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorentwicklung). pp 11p, Paper E2/3 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Hypothetical reactor accidents are characterized by a sudden release of substantial thermal energy in one fuel element. Presently it cannot be excluded that for instance pressure pulses due to a fuel coolant interaction may have such time scales and impulses as to deform neighboring subassemblies permanently. Additionally coherent fuel element motion may limit control rod scram action and possibly cause untolerable reactivity increases. Therefore LMFBR safety requires analysis of the complex mechanical response of the core structure under typical loading conditions. An important contribution to this problem is to examine the nonlinear structural dynamics of an individual fuel element under prescribed loading and boundary conditions. The subject of this paper is the elastoplastic transient behaviour of one subassembly under given space-and-time dependent pressure loading. The interaction of several colliding fuel elements including coolant dynamics is briefly discussed.

24789 Numerical analysis oriented biaxial stress-strain relation and failure criterion of plain concrete. Link, J. (Technische Univ. Darmstadt (Germany, F.R.)). pp 12p, Paper H1/2 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

For a numerical analysis, e.g. by Finite Differences or Finite Element Method, there is still a lack of knowledge on the level of incorporating a material behaviour law for concrete beyond the linear elastic range. A biaxial stress-strain relation and failure criterion is proposed, which is applicable to the above mentioned structural analysis methods.

24790 Fracture mechanics evaluation of the Trino Vercellese reactor vessel following a postulated main coolant pipe break. Mager, T.R. (Westinghouse Electric Nuclear Energy Systems Europe (WENESE), Brussels (Belgium)); Meyer, T.A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). PWR Systems Div.); Calliani, M. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). pp 10p, Paper G5/4 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Results of a parametric study performed on the Trino reactor vessel to evaluate the thermal effects resulting from a posulated LOCA are presented. The parametric study included the variable of flow rate (9300, 12245 and 18700 gpm) and coolant temperature (53.6, 70 and 100°F). In addition, post-irradiation fracture toughness data were obtained on the Trino reactor vessel material to ensure completeness of the analysis. The material exhibited a post-irradiation upper shelf fracture toughness of 150 ksi (in)sup(1/2). The paper describes the potential of crack instability during a postulated LOCA condition considering the variables evaluated. The results of the parametric study shows that by controlling the Safety Injection System coolant flow rate and/or coolant temperature, the critical flaw size is greater that 25 percent of the reactor vessel shell thickness.

24791 Concept of elasticity used in some fast reactor accident analysis codes. Malmberg, T. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorentwicklung). pp 13p, Paper E3/7 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The analysis presented restricts attention to the elastic part of the elastic-plastic equation used in several Fast Reactor Accident Analysis Codes and originally applied by M.L. Wilkins: Calculation of Elastic-Plastic Flow, UCRL-7322, Rev. 1, Jan 1969. It is shown that the used elasticity concept is within the frame of hypo-elasticity. On the basis of a test found by Bernstein it is proven that the state of stress generally depends on the path of deformation. Therefore this concept of elasticity is not compatible with finite elasticity. For several deformation processes this special hypo-elastic constitutive equation is integrated to give a stress-strain relation. The path-dependence of this relation is demonstrated. Further the phenomenon of hypo-elastic yield under shear deformation is pointed out. The relevance to modelling material behaviour in primary containment analysis is discussed.

24792 Response of hexagonal fuel assembly coupled with internal hydrodynamics. Marchertas, A.H.; Julke, R.T. (Argonne National Lab., Ill. (USA)). pp 15p, Paper E1/7 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

For safety considerations of sodium cooled fast breeder reactors the mechanistic accident-initiating conditions must be studied. In previous investigations of such initiating accidents the models assumed axisymmetric configurations and in general neglected the coupling effects with the subassembly boundary. In fact the fuel subassembly ducts are usually not axisymmetric but rather of hexagonal shape. This paper presents a more precise treatment of the subassembly boundary and also provides feedback of the boundary response to the pressure source. This is accomplished by making use of two computer codes: REXCO-HT and SADCAT.

24793 Dynamic analysis of structural systems with internal gaps under axial impact loading. Matthees, W. (Bundesanstalt fuer Materialpruefung, Berlin (Germany, F.R.). Abt. Bauwesen). pp vp, Paper E4/11 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

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24794 High temperature deformation model for Zircaloy clad bulging under LOCA conditions. Merckx, K.R. (Exxon Nuclear Co., Richland, Wash. (USA)). pp 8p, Paper C3/7 of In Structural mechanics in reactor technology. Vol. 1. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

During the hypothetical design base loss-of-coolant accident (LOCA), the coolant depressurization and reduced coolant flow causes a pressure differential across the fuel clad and high cladding temperatures. Cladding deformations and the potential for clad bulging must be evaluated for these conditions. This paper presents a plastic-creep deformational model for the Zircaloy cladding for application under prototype LOCA environmental conditions. The plastic contribution to deformation is based upon fuel clad burst test

data for temperatures below 780°C (1435°F) and on rapid heatup burst test data above this temperature.

24795 Nonlinear elastic analysis for stability near yield of cylindrical shells subjected to dynamic LOCA pressures. Norton, P.J.; Chandra, S. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). pp vp, Paper F1/10 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

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24796 Stress and deflection analysis of reactor internals due to seismic and maximum hypothetical LOCA loading conditions. Ramani, D.T. (Motor-Columbus Ingenieurunternehmung A.G., Baden (Switzerland)). pp 14p, Paper F1/9 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The importance of knowledge of seismic and LOCA load responses of reactor internals is related to safety and operational requirements in assessing the adequacy, structural integrity and flawless functioning of each reactor component. Following a loss-of-coolant accident the integrity of the core internals must be maintained to ensure safe and orderly shutdown of the reactor. This implies that gross deformation of the core and internals does not occur, control rod insertion is not prevented, and that deformation of the internals is slight and thus does not impede coolant and safety injection flow. This paper encompasses criteria and methods of analysis used for predicting dynamic response of typical 900 MWe PWR reactor internals subjected to simultaneous occurrences of seismic and LOCA loads in which individual responses are added directly. The study discusses mathematical modelling techniques of reactor internals, whereby components, such as reactor vessel, upper and lower grid assemblies, core mass including fuel assemblies, core-support structure, plenum assembly, control rod drives and skirt support, are idealized into a planar two-dimensional multi-degree lumped-mass system of flexible massless beam elements, interconnected by nodes.

24797 Dynamic analysis of primary reactor coolant system subjected to seismic and LOCA loads, including shield-building interaction. Ramani, D.T. (Motor-Columbus Ingenieurunternehmung A.G., Baden (Switzerland)). pp 14p, Paper F5/3 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

This paper is intended to describe the development of a unique method of analysis for a primary reactor coolant piping system to evaluate its adequacy and a need for structural support system optimization under hypothetical seismic and loss-of-coolant-accident loading conditions. An integrated approach is presented for a linear three-dimensional dynamic analysis of a typical 900 MWe PWR nuclear reactor coolant loop, accomodating dynamic-coupling and interaction effects of shield-building including soil-foundation springs and damping parameters. Also included are major influences on sensitive equipment due to their variable support boundary conditions and rigid restraints. Due to the vital nature of reactor coolant system, important dynamic design criteria have to be established in accordance with estimating natural frequencies, damping characteristics and behaviour of the overall system during LOCA and strong motion earthquakes as well as to optimize the structural design of various components.

24798 Conceptual design of pipe whip restraints using interactive computer analysis. Rigamonti, G.; Dainora, J. (United Engineers and Constructors, Inc., Philadelphia, Pa. (USA)). pp 8p, Paper F5/4 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Protection against pipe break effects necessitates a complex interaction between failure mode analysis, piping layout, and structural design. Many iterations are required to finalize structural designs and equipment arrangements. The magnitude of the pipe break loads transmitted by the pipe whip restraints to structural embedments precludes the application of conservative design margins. A simplified analytical formulation of the nonlinear dynamic problems associated with pipe whip has been developed and applied using interactive computer analysis techniques. In the dynamic analysis, the restraint and the associated portion of the piping system, are modeled using the finite element lumped mass approach to properly reflect the dynamic characteristics of the piping/restraint system. The analysis is performed as a series of piecewise linear increments. Each of these linear increments is terminated by either formation of plastic conditions or closing/opening of gaps. The stiffness matrix is modified to reflect the changed stiffness characteristics of the system and re-started using the previous boundary conditions. The formation of yield hinges are related to the plastic moment of the section and unloading paths are automatically considered. The conceptual design of the piping/restraint system is performed using interactive computer analysis. The application of the simplified analytical approach with interactive computer analysis results in an order of magnitude reduction in engineering time and computer cost.

24799 Dynamic structural loads produced by large sodium-water reactions in LMFBR steam generators. Shin, Y.W.; Valentin, R.A. (Argonne National Lab., Ill. (USA)). pp 9p, Paper E4/5 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

In the design of secondary heat transport systems for a large Liquid Metal Fast Breeder Reactor (LMFBR), it is necessary to assume that at some time during the life of the plant, a tube failure will occur in a superheater or evaporator. The resulting large sodium-water reaction will generate temperatures and pressures far in excess of nominal values. To assess the damage potential of such an event during its initial stages, it is necessary to consider compressibility of the sodium as well as geometric details of the steam generator. This paper describes initial results obtained from a two-dimensional, compressible, inviscid hydrodynamics model developed to determine the loading on the steam generator and its internals. It forms part of a comprehensive analysis development activity to assess the potential for additional tube failures, system integrity, and pressure transmission to the reactor intermediate heat exchanger.

24800 Analysis of LMFBR explosion model experiments by means of the SURBOUM-II code. Stievenart, M.; Bouffioux, P.; Egleme, M.; Fabry, J.P.; Lamotte, H. (Societe Belge pour l'Industrie Nucleaire, Brussels). pp 11p, Paper E3/5 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Experiments have been carried out to simulate in small scale vessels the occurrence of an Hypothetical Core Disruptive Accident (HCDA) for the SNR-300 reactor. In parallel with the experimental programme, the (2D) computer code SURBOUM-II has been developed. The code computes the two-dimensional fluid flow within the system in case of a core explosion. The fluid is assumed incompressible and the deformations of the concrete shell(s) and vessel(s) are calculated by means of the thin shell theory. Perforated dip plates which are included in the model are treated as a particular type of boundary conditions involving empirical pressure drop versus flow relationships. The first part of the interpretation work was the determination of the pressure-volume relationship of the slow burning charge used to simulate the HCDA. This has been achieved by an original trial and error method built in the code which fits best the experimental impulse time records obtained in bare charge experiments fired in overstrong vessels. Other experiments carried out in overstrong vessels and involving a perforated dip plate above the core to damp out the fluid impact on the roof were calculated and the comparison of the theoretical and experimental impulse time curves was satisfactory. Further experiments, with and without the perforated dip plate, carried out in yielding vessels were also interpreted. For those experiments the scope of the work was the comparison of calculated and measured deformation of the vessel. The agreement obtained is satisfactory, through the code seems to overestimate slightly the final deformation.

24801 Dynamic inelastic structural response associated with large sodium-water reactions in LMFBR heat transport systems. Valentin, R.A.; Lin, H.C.; Hsieh, B.J. (Argonne National Lab., Ill. (USA)). pp 12p, Paper E4/6 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Failure of a steam tube in a Liquid Metal Fast Breeder Reactor (LMFBR) evaporator or superheater results in a large exothermic sodium/water reaction and generates pressure pulses far in excess of nominal operating pressures. To determine the structural integrity of the heat transport system and to model the transient behaviour of the reaction products relief system, it is necessary to predict the inelastic response of several components. This paper develops models for the dynamic response of the shell structures within the system and also the dynamic plastic response of the relief system rupture discs. These two problems require completely different mathematical formulations for efficient solution. A comparison between the two methods is included as well as their relationship to the comprehensive analysis system being developed for treating the entire sodium/water reaction event.

24802 Application of the implicit Eulerian method (ICECO) to fast reactor containments. Wang, C.Y.; Chu, H.Y.; Chang, Y.W.;

Fistedis, S.H. (Argonne National Lab., Ill. (USA)). pp 11p, Paper E3/4 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

This paper describes the applications of the Implicit Eulerian method to the solution of safety problems related to the fast reactor containment. Three problems studied by the ICECO code are: (1) response of primary containment to a low-energy excursion, (2) the effect of wall opening on the slug impact and sodium spillage, and (3) dynamics of gas bubble during an HCDA. Results of these studies not only reveal certain special merits of the Eulerian analysis, but also demonstrate the capability of the ICECO code which can be used to investigate problems not previously tractable by the Lagrangian technique.

24803 Discretization and time integration techniques for transient nonlinear dynamics of fast reactor subassemblies. Zehlein, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorentwicklung). pp 14p, Paper E2/2 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The mechanical damage eventually occurring to a fast reactor fuel subassembly under an external MFCI-type vapor explosion must neither hamper the immediate scram nor produce dramatic reactivity changes. To demonstrate that this safety requirement is always met, an accurate numerical analysis of the transient hexcan behavior must include the pin-bundle and the liquid sodium inside. Therefore, the model theory discussed in this paper considers how properties like time-varying mass distribution and a hexagonal cross section flattening together with the strongly stiffening pin-bundle, and energy dispersion and dissipation due to axial fluid expulsion and growth of plastic zones as well as distributed pressure forces and inertia terms affect the elastoplastic bending of a single subassembly which is treated as a Timoshenko beam (i.e. shear and rotary inertia are not neglected).

24804 Solid fluid interaction in confined flows. Sundararajan, V. (Indian Inst. of Tech., Kanpur. Dept. of Mechanical Engineering and Nuclear Centre). pp vp, Paper F2/9 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24805 Failure of torispherical ends of pressure vessels due to instability and plastic deformation - an experimental investigation. Kirk, A.; Gill, S.S. (Univ. of Manchester Institute of Science and Technology, Manchester (UK). Dept. of Civil and Structural Engineering). pp 10p, Paper G2/2 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Twelve model pressure vessels with torispherical ends have been tested under internal pressure to investigate failure by instability and plastic deformation. The models covered combinations of three head heights and four thicknesses. All the thicker specimens with internal diameter/thickness ratios of 53, 106 and 212 failed by plastic deformation. The three thin specimens with internal diameter/thickness ratio of 530 failed by buckling of the torus due to the circumferential compressive stresses. The experimental results for limit pressure and instability failure are compared with theoretical values. The effect of change of geometry is significant particularly for the larger head heights. For these specimens the experimental limit pressure is higher relative to theoretical predictions than is the case for the smaller head heights. A simple approximate theory is presented for predicting the pressure at which buckling occurs in the torus. The predictions are higher than the experimental values but are not as high as previously published predictions.

24806 Role of scale model tests in solving problems in structural dynamics. Abrahamson, G.R. (Stanford Research Inst., Menlo Park, Calif. (USA). Poulter Labs.). pp 13p, Paper E4/2 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Scale model tests are often used in developing solutions to problems where theory alone is inadequate and full-scale tests are too costly. In this paper the author reviews the physical basis for scale model tests, together with their limitations, and presents examples of the effective use of scale model tests in past and current R and D work in structural dynamics. Scale model tests are particularly attractive in LMFBR safety investigations of containment integrity under loads due to and HCDA, sodium-water interaction in a heat exchanger, or plant missile impact. Past scale model work on these problems has yielded valuable results, and future applications are envisaged.

24807 Reliability of nuclear reactor pressure vessels based on probabilistic fracture mechanics. Becher, P.E. (Danish Atomic Energy Commission, Risoe. Research Establishment). pp vp, Paper G3/2 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24808 Energy source and fluid representation in a structural response code-STRAW. Belytschko, T. (Illinois Univ., Chicago (USA)); Kennedy, J.M. (Argonne National Lab., Ill. (USA)). pp 12p, Paper E1/4 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

In evaluating the transient response of reactor components such as fuel subassemblies, the interaction of these components with their environment plays a critical role. Preliminary studies indicate that the surrounding coolant and the adjacent subassemblies interact quite strongly with the accident subassembly, so that the response predicted in studies on an isolated accident subassembly is considerably greater than what would actually occur in the environment of the reactor, particularly for loads with rise times of 1 msec or less. Therefore, unless these surroundings are included, in design or safety evaluations, the conclusions drawn are unduly conservative. This paper describes three additional developments in the STRAW (Structural Transient Response of Assembly Wrappers) code for including the effects of surroundings: (1) hydrodynamic finite elements, which are used to represent the plane motion of the fluid surrounding and within the subassemblies; (2) a superimposed superelement which represents the effects of axial flow; (3) an energy source model identical to that used in REXCO which can be used to model molten fuel coolant interactions (MFCI) or other envisioned energy release sources such as cladding-coolant interaction.

24809 Inelastic behaviour, failure modes and ultimate load design of prestressed concrete pressure vessels. Berqvam, T.; Fluge, F.; Gausel, E.; Lenschow, R. (Trondheim Univ. (Norway)). pp 11p, Paper H4/7 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

A research programme concerning the behaviour in the inelastic range to rupture on six model vessels is now completed. The geometry of the models is scaled 1:36 to the Scandinavian PCPV-model (reference pressure 84 kp/cm^2). Geometrical data: external height 180 cm, external diameter 120 cm. Diagrams of total deflections up to failure are presented together with corresponding strains measured in linear and bonded reinorcement, and are compared with computed values. Calculations of the pressure/deformation relation for the plastic range up to failure are presented, together with final conclusions of the test series.

24810 Analysis of cracked structures. Davidson, I. pp 12p, Paper H4/1 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The methods described were derived in order that PCRVs could be analysed when they were loaded up to failure, and they have been justified by reference to experiments on model PCRVs. The methods have a very wide application, in particular to reinforced concrete structures, which must crack before they can function. Cases of dynamic loading e.g. explosion, earthquakes, can also be analysed accurately.

24811 Plastic collapse pressures for conical and toriconical ends of cylindrical pressure vessels and their relationship to design rules in various standards. Davie, J.; Elsharkawi, K.; Taylor, T.E. (Univ. of Manchester Institute of Science and Technology, Manchester (UK). Dept. of Civil and Structural Engineering). pp vp, Paper G2/1 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24812 Assessment of the reliability of nuclear pressure vessels. Egan, G.R.; Besumer, P.M. (Failure Analysis Associates, Palo Alto, Calif., USA). pp vp, Paper G3/1 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

24813 Pulse propagation in fluid-filled pipes. Florence, A.L. (Stanford Research Inst., Menlo Park, Calif. (USA). Poulter Labs.). pp 10p, Paper F4/8 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Experiments are described that were carried out to study fluid pulse propagation behavior in the primary piping of the Fast Flux Test Facility. The pulse is that generated by a hypothetical core disruptive accident (HCDA) within the Fast Test Reactor (FTR). Of particular interest are the pulse shape entering the piping and the subsequent effect on the pulse shape of elbows and plastic yielding of the piping. This information is useful for assessing the vulnerability of components in the primary loop, especially the intermediate heat exchanger.

24814 Crack analysis of multicavity prestressed concrete reactor vessels. Gallix, R.; Liu, T.C.; Lu, S.C.H. (General Atomic Co., San Diego, Calif. (USA)). pp 12p, Paper H4/2 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

A new method to perform the crack analysis of non-axisymmetric, multicavity prestressed concrete reactor vessels (PCRV's) subjected to hypothetical overpressure by using an axisymmetric, two-dimensional finite element computer code is presented. Such analysis is necessary to verify the PCRV will have a gradual response as its structural capacity is approached and will develop the specified minimum ultimate load capacity.

24815 Critical evaluation of the heavy section steel technology program. Part one. Holt, A.B. pp 10p, Paper G3/4 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Part one covers the Program until the time of the testing of the first of the intermediate test vessels, i.e.; the period from 1967 till summer 1972. This is the preparatory period when the Program readied itself for the main task which is expected to provide an extensive base for the extrapolation of failure hypothesis to full-size vessels. The accomplishments of the Program during the first five years of its existence falls under two main categories. (A) Testing and characterization of thick-section steel. (B) Proposing and developing the Equivalent Energy Method leading to a new fracture toughness parameter which has been given the symbol Ksub(Icd).

24816 Probabilistic brittle fracture analysis for major thermal transients in pressure vessels. Jouris, G.M.; Shaffer, D.H. (Westinghouse Research Labs., Pittsburgh, Pa. (USA)). pp 9p, Paper G3/3 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Brittle fracture of a pressure vessel during a major thermal transient occurs when the thermal stresses induced by the transient combine with the operating stresses to give a stress intensity at the tip of an existing crack which exceeds the critical stress intensity for that time and position in the vessel. The determination of both the local stress intensity, K_I, and the critical stress intensity, Ksub(IC), depends on inferential analysis of various kinds of material data. In the initial attack of this problem, only Ksub(IC), the critical stress intensity, was treated as a random variable. Available data from the HSST program were studied and it was determined that a three-parameter gamma distribution with temperature dependent parameters gave a satisfactory description of the observed Ksub(IC) variability. In order to treat transients occurring after vessel service of specified duration, irradiation embrittlement is introduced and a random variable defined for the shift in nil-ductility temperature. Again available data are studied to generate satisfactory distributions for ΔRTsub(NDT) and obtain estimates of the necessary parameters. Appropriate Monte Carlo techniques for estimating the brittle fracture probability are employed. In conclusion it is shown how to extend this methodology to incorporate more components of variability, including some in the calculation of K_I.

24817 Crack propagation on spherical pressure vessels. Lebey, J.; Roche, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service des Etudes Mecaniques et Thermiques). pp 12p, Paper G4/4 of In Structural mechanics in reactor technology. Vol. 3. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The risk presented by a crack on a pressure vessel built with a ductile steel cannot be well evaluated by simple application of the rules of Linear Elastic Fracture Mechanics, which only apply to brittle materials. When ductile steels are used, large-scale yielding can occur before fracture, and LEFM is not suitable in that case. A rough analysis shows that the kind of fracture of a cracked vessel depends on the size of the crack. Large-scale vessels behave like brittle ones if a crack with a critical length can appear. For small-scale vessels, a crack only reduces the stressed area and fracture will be of ductile type. In safety assessments the most unfavorable criterion should therefore be known and applied. Tests were carried out on spherical vessels of three different scales built with the same steel. Cracks of different length were machined through the vessel wall. From the results obtained, crack initiation stress (begining of stable propagation) and instable propagation stress may be plotted against the lengths of these cracks. For small and medium size, subject to ductile fracture, the resulting curves are identical, and may be used for ductile fracture prediction. Brittle rupture was observed on larger vessels and crack propagation occured at lower stress level.

24818 Transient thermal stresses in emergency cooling systems of a reactor and the application to circuit integrity. Otter, N.; Mailer, D.; Jackson, P. (General Electric Co. Ltd., Whetstone (UK). Mechanical Engineering Lab.). pp 15p, Paper F3/9 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

In an emergency situation, cold water at 70°F is pumped via the emergency cooling system into the normal working parts of the reactor. The pipework, initially at 540°F, consequently suffers a series of thermal shocks over its lifetime in addition to the normal pressure loadings. It is necessary therfore to assess the integrity of simple parts of the system, such as plain pipes and standard Ts, under these conditions over their lifetime, before setting up a research program to investigate the more complicated parts. The transient temperature and subsequent stress distributions were calculated by means of the finite element method, the temperatures on a triangular mesh, the nodes of which formed the isoparametric element mesh used in the stress calculations. The boundary conditions were assumed constant and a range of heat transfer coefficients taken. It was established that the simple parts of the emergency cooling system were safe, under pessimistic assumptions, provided that the minimum acceptable defect size was detectable.

24819 Structural analysis of piping after a large pipe break in a WWER-440 type reactor. Ikonen, K.; Reijonen, H. (Valtion Teknillinen Tutkimuskeskus, Otaniemi (Finland). Ydinvoimatekniikan Lab.); Kangas, V.M. (Imatran Voima Oy, Helsinki (Finland)). pp F5/2 1-10 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

In the WWER-440 reactor the primary piping consists of six horizontal loops going radially from the pressure vessel, each loop having a horizontal steam generator. In this reactor type the relatively long primary piping with many curved sections requires special attention in order to successfully eliminate the consequences of the design basis accident. Emergency supports are located in appropriate places to restrict the movements of the pipe in 1, 2, 3, or 4 directions depending on the geometry of the pipe near the support. Under normal conditions there is a gap of some centimeters between the pipe and a support so that the pipe can be deformed freely under changing loads. In order to analyse the behaviour of the broken piping system with the support structures a computer code called PIPEBREAK has been written. The main objects in the analyses have been to calculate the deformations of the supports and to evaluate the stresses in the pipe. The results indicate that the stresses during the pipe whipping in the pipe exceeded the static yielding point of the material, but the time intervals during which the yielding point is exceeded are short.

24820 Pressure source for loading subassembly ducts. Cagliostro, D.J. (Stanford Research Inst., Menlo Park, Calif. (USA). Poulter Labs.); Marciniak, T.J. (Argonne National Lab., Ill. (USA)). pp E1/2 1-13 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

In the safety analysis of Liquid Metal Fast Breeder Reactors, the computer code STRAW (Structural Transient Response of Assembly Wrappers) predicts the response of hexagonal fuel-subassem-

bly ducts (hexcans) to internally generated pressures caused by molten fuel-coolant interactions (MFCI) and fission gas release. Validation of STRAW requires corroboration from experiments in which a well-defined pressure pulse internally loads a hexcan and the resulting deformation and strain in the accident and surrounding hexcans are measured. The paper describes the experimental and theoretical development of a shock-free pressure source that produces inside a hexcan uniform pressure pulses expected in a subassembly.

24821 Analysis of severe accidents on fast reactor test loop. Cenerini, R.; Verzelletti, G. (Commission of the European Communities, Ispra (Italy). Joint Research Centre); Curioni, S. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy)). pp E4/8 1-9 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The Pec reactor is a sodium cooled fast reactor which is being designed for the primary purpose of accomodating closed sodium cooled test loops for the developmental and proof testing of fast reactor fuel assemblies. The test loops are located in the central test region of reactor. The basic function for which the loop is designed is burn-up to failure testing of fuel under advanced performance conditions. It is therefore necessary to design the loop for failure conditions. Basically two types of accidents can occur within the loops: rupture of gas plenum in the fuel pins and coolant starvation. Somewhat similar consequences can be expected from these two accidents: a large amount of the heat that was built up in the fuel could be transfered to the coolant very rapidly. The design of the loop should take into account the amount of dynamic work that would be done in the relief of the high temperature and pressure consequent to this accident. Explosive tests on Pec loop, whose first set is described in this report, are devoted to investigate the effects on an accidental energy release on loop containment.

24822 Experimental simulation of molten fuel externally contacting an operating LMFBR fuel subassembly. Pierce, R.D.; Smith, J.L.; Miller, W.E.; Pedersen, D.R.; Wilson, R.E.; Helenberg, H.W. (Argonne National Lab., Ill. (USA)); Ariman, T. (Notre Dame Univ., Ind. (USA)). pp E1/5 1-8 of In Structural mechanics in reactor technology. Vol. 2. Jaeger, T.A. (comp.). Amsterdam; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

One area of safety for the USA Liquid Metal Fast Breeder Reactor Program relates to the effect of a potential failure of a local fuel subassembly on adjacent subassemblies. The current subassembly design has an array of 217-fuel elements (0.58 cm dia) in a hexagonal duct. The ducts are 0.30-cm thick and 6.45-cm across each face. The study concerns the effect of fuel meltdown in one subassembly on adjacent subassemblies containing undamaged fuel and flowing sodium. The molten fuel could result in a heat flux of up to 600 W/cm^2 on a portion of one face of each adjacent cut. This flux would result in a temperature drop of about 725^0C through the duct wall. The effects of the accompanying thermal stresses are to be determined. Sodium boiling is not expected in the adjacent subassembly unless the duct and adjoining fuel elements are severly distorted.

24823 (JPNRSR—5) Experimental study on limit design for nuclear power facilities during earthquakes, 1973. Teidoguchi, H. (Japan Electric Association, Tokyo). Feb 1975. Translation of Japanese report 50-1705. 154p. Dep. NTIS (US Sales Only) $6.75.

Work performed under United States Nuclear Regulatory Commission—Light Water Reactor Safety Technical Exchange Program.

Seismic design studies involving nuclear power plant piping are described. Included are static load tests and vibrational tests on pipe systems including straight pipe, curved pipe, and T-branched fittings. (DG)

24824 Nuclear reactor. Braun, W.; Irion, L. (to Kraftwerk Union A.G.). German(FRG) Patent 2,424,427/B/. 7 Aug 1975. 8p. (In German).

12 figs.

To prevent back-flow of coolant from the pressure vessel of a PWR or BWR into the cold loop in case of rupture of the primary circuit, the primary loop is provided with a swing check valve unit. It is mounted in the pressure vessel and surrounds the outlet fromed by a pipe nozzle. The arrangement may be eccentric in order to get a uniform flow velocity at all valves. The single flaps of the swing check valve unit are placed in a latticed frame which, as a whole, can be mounted on the pipe nozzle or the core tank of the pressure vessel. The flaps have got rectangular cross-section and form plates supported by swivel axes. By subdividing the unit into many single flaps, the safety of the plant is increased as in case of failure, e.g. of one flap, throttling of the flow in an emergency is nearly retained.

24825 Heat transfer problems in nuclear reactor safety. Hall, W.B. (Manchester Univ. (UK). Simon Engineering Labs.). *Proc. Inst. Mech. Eng. (London);* **190**: No. 24, 215-224(1976).

Reactor safety assessment is a highly specialized topic which, in many of its aspects, depends heavily on a satisfactory understanding of a wide variety of heat transfer phenomena. Some of these problems outside the ranks of the reactor safety specialists are considered. Typical liquid-cooled reactors, their operating characteristics, and some heat transfer aspects of their safety assessment are discussed: for example, transient boiling, quenching of hot surfaces and thermal explosions.

24826 Assessment of the integrity of PWR pressure vessels. London; H.M. Stationery Office (1976). 162p.

In connexion with an assessment of the safety of pressurized water reactors for UK conditions, a study was made of reactor pressure vessel integrity. The present document is a summary of the full report, but all the conclusions, recommendations and qualifications contained in the full report are reproduced here exactly. Following an explanatory introduction, the subject is covered in sections, entitled: description of pressure vessel; materials (composition of the steels, welds, cladding, and their mechanical properties); design (operating conditions, and design against failures of various types); manufacture (fabrication, examination and repair); in-service inspection; quality assurance; pressure vessel failure probabilities; conclusions and recommendations.

24827 (ERDA-tr—251) Historical development of safety criteria for nuclear power plants. Talarek, H.D. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Nukleare Sicherheitsforschung). 1976. Translation of KFA-ISF-IB—1/76. 22p. Dep. NTIS $3.50.

A short account of the ideas governing the formulation of safety criteria over the past 20 years is given. The basic ideas of the concepts of risk, DBA, MCA and isolation are summed up and discussed.

24828 Questions for the Nuclear Installations Inspectorate. Conroy, C.; Flood, M.; MacRory, R.; Patterson, W.C. London; Friend of the Earth (1976). 17p.p.

In response to the invitation by the U.K. Secretary of State for Energy for interested individuals or organisations to submit questions to the Nuclear Installations Inspectorate, a document has been published by the organisation 'Friends of the Earth' which poses many questions relating to nuclear safety. To determine which of these might be appropriate to ask the NII, a brief survey is first presented of the responsibilities of the NII and other bodies, such as the Health and Safety Executive, with responsibilities in the field of nuclear safety and security. Some critical comments concerning existing arrangements, and some general questions, are put forward for discussion. Many detailed questions are then presented for the NII to answer on a number of issues concerning the safety of nuclear reactors, plants, and processes. These relate to specific incidents occuring in, and problems encountered with, Magnox reactors, problems of the SGHWR, specific aspects of fast reactor safety, and finally, numerous questions concerning reprocessing and waste.

24829 Two-phase flow model with nonequilibrium and critical flow. Sureau, H.; Houdayer, G. (Electricite de France, 92 - Courbevoie. Service Etudes et Projets Thermiques et Nucleaires). pp 267-278 of In Ecoulements diphasiques et cavitation dans les systemes de production d'energie. Paris; Societe Hydrotechnique de France (1976). (In French)

From Symposium on two phase flow and cavitation in power generation systems; Grenoble, France (30 Mar 1976).

The model proposed includes the three conservation equations (mass, momentum, energy) applied to the two phase flows and a fourth partial derivative equation which takes into account the nonequilibriums and describes the mass transfer process. With this model, the two phase critical flow tests performed on the Moby-Dick loop (CENG) with several geometries, are interpreted by a unique law. Extrapolations to industrial dimension problems show that geometry and size effects are different from those obtained with earlier models (Zaloudek, Moody, Fauske).

24830 Recent results from TREAT tests on fuel, cladding, and coolant motion. Dickerman, C.E.; Barts, E.W.; Volpi, A.De; Holtz, R.E.; Murphy, W.F.; Rothman, A.B. (Argonne National Lab., Ill. (USA)). *Ann. Nucl. Energy;* 3: No. 5;6, 315-322(1976).

From European nuclear conference; Paris, France (Apr 1975).

New data obtained from post mortem examination are reported on the transient in-pile tests in the TREAT reactor. Additional experiments are described which were conducted to clarify the phenomena producing fuel motion and for assessing the role of cladding motion as it might limit or otherwise affect fuel motion. The results which are discussed show that a general picture of dispersal is emerging from the tests. Post-mortem data indicate that the post-transient overpower or post loss-of-flow is such that continuous dispersal will occur to steel vapourization. The data do not support models using idealized fuel-coolant mixing and explosive vapour expansion to predict energetic sodium vapourization events.

24831 Device to control accidents in nuclear power plants. Bukrinsky, A.M.; Matskewitsch, G.; Rschesnikow, J.W.; Suchow, A.B.; Tatarnikow, W.P.; Berkowitsch, W.M.; Remschin, J.N.; Slepnew, L.N.; Swerdlow, A.N.; Karan, W.G. (to Vsesoyuznyj Nauchno-Issledovatel'skij Teploteknicheskij Inst.). German(FRG) Patent 2,525,119/A/. 15 Jan 1976. 21p. (In German).

5 figs. Available from Dt. Patentamt, Muenchen (FRG).

A control system for loss of coolant in a nuclear power plant is dealt with. The arrangement of a pressure suppression system consisting of several condensers is described.

24832 Flywheel with bursting safeguard. Hintergraeber, M. (to Kraftwerk Union A.G.). German(FRG) Patent 2,338,265/C/. 29 Jan 1976. 5p. (In German).

4 figs. Available from Dt. Patentamt, Muenchen (FRG).

To guarantee the safety in nuclear power plants, a flywheel which can be used therein is improved in such a way that it does not do any damage in case of accidents. It has a burst protection for protection against excessive speeds of the shaft: A force acts in the direction of the front side of the shaft portion and more particularly on the small diameter of a frustro-conical shaft portion shrunk on the flywheel, and a catching and centering device is provided for the flywheel in said direction and adjacent to the latter.

24833 Safety of nuclear installations. Ramanna, R. (Bhabha Atomic Research Centre, Bombay (India)). *Chem. Petro-Chem. J.;* 7: No. 2, 23-33(Feb 1976).

10 refs.; also published in 'Electrical India' (15 Apr 1976) v. 16(7) p. 17-27.

A detailed account of the safety aspect in connection with nuclear installations is given. Questions concerning natural risks from any installation, radioactive risks from nuclear installations leading to environmental and genetic damage, problems of waste disposal, and the inevitability of the use of nuclear energy in human progress are discussed. The internationally accepted standards of safety and statistics on accidents due to various causes in different countries are also presented.

24834 Causes and prevention of reactor accidents. Shah, P.K.; Mehta, J.N. *Inst. Sci. Mag.;* 45: 9-12(Mar 1976).

The events leading to the loss of coolant followed by failure of containment are reported. These events are classified as: (a) primary system integrity (b) events other than rupture of primary system (transients) and (c) quality assurance. Various factors affecting primary system integrity are discussed. Factors resulting in transients such as reactivity changes due to inadvertant control rod withdrawal, equipment failure, and recirculating pump-turbine trip are described. Safe reactor operation depends heavily upon maintaining high quality of components and reliability of reactor system. Quality assurance encompasses the procedures necessary to ensure that the specifications written in design and operation plans are met in practice. The necessary precautions to be observed for smooth reactor operation are mentioned.

24835 Nuclear reactor with a containment and reactor pressure vessel and a pressure suppression vessel arranged in the containment. Kuschel, D.; Mueller, W.F.; Schlosser, G.; Zeitzschel, G.; Voss, A. (to Licentia Patent-Verwaltungs-G.m.b.H.). German(FRG) Patent 2,023,343/B/. 25 Mar 1976. 4p. (In German).

3 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention relates to a nuclear reactor with a containment and a reactor pressure vessel and a pressure suppression vessel arranged in the containment, the reactor pressure vessel being arranged in a pressure chamber of such strength that it withstands the pressure freed during rupture of the reactor pressure vessel. This pressure chamber has connections to the pressure suppression system the free cross sections of which are, on the whole, dimensioned in such a way that the amount of vapor passing after the rupture of the reactor pressure vessel corresponds nearly to the condensation capacity of the pressure suppression vessel.

24836 Structural analysis and design of a nuclear power plant building for aircraft crash effects. Degen, P.; Furrer, H.; Jemielewski, J. (Motor-Columbus Ingenieurunternehmung A.G., Baden (Switzerland)). *Nucl. Eng. Des.;* 37: No. 2, 249-268(May 1976).

From International seminar on extreme load conditions and limit analysis procedure for structural reactor safeguards and containment structures; Berlin, Germany, F.R. (8 Sep 1975).

The object of this investigation is to assess the effect of a large commercial airplane crashing perpendicularly on to the surface of a spherical reactor building dome. This investigation is related to a project currently in execution. Practical solutions of the postulated case, which vary in the degree of engineering effort used, are shown. Based on safety consideration the various solutions are discussed from the viewpoint of penetration, cracking and collapse modes of failure, where, primarily, the carrying capacity of the structure under an equivalent static load is considered. The performed investigations include: (a) Calculation of the failure load following the yield line theory; (b) Calculation of the sectional forces using the linear-elastic shell theory and subsequent design by the ultimate strength method; (c) Calculation of the failure load, establishing of the failure mechanism and distribution of sectional forces using the plastic shell theory; (d) Calculation using a three-dimensional FEM program with plastic capabilities; this includes the collapse load, the failure mechanism and the distribution of sectional forces. A discussion of the resultant forces and the configuration of the critical section is given for the various methods used. The evaluation of the carrying capacity of the structure with respect to load is based on energy considerations. It is attempted to compare such results, to evaluate possible simplifications in the used solutions, and to give some recommendations for the practical design and for the development of structural details.

24837 Calculation of the total force acting upon a rigid wall by projectiles. Drittler, K.; Gruner, P. (Technischer Ueberwachungs-Verein Rheinland e.V., Koeln (Germany, F.R.)). *Nucl. Eng. Des.;* 37: No. 2, 231-244(May 1976).

From International seminar on extreme load conditions and limit analysis procedure for structural reactor safeguards and containment structures; Berlin, Germany, F.R. (8 Sep 1975).

A numerical method is presented which allows for the calculation of the total force acting upon a building during impact of a projectile. The structural part to be hit by the projectile is assumed to be rigid; its surface is perpendicular to the direction of impact. Flight trajectory and projectile axes coincide. Variations of geometric and material properties across the projectile axis are replaced by proper average values. The computation algorithm is based on a difference method. The projectile model has to be divided into elements along the flight trajectory. Except for the elements at the beginning and end of the projectile each element is in equilibrium with its neighbour elements. Different elastic and plastic material properties for each element can be taken into account. Strongly deformed elements are assumed to become separated from the projectile. The impact of all debris is calculated as a part of the total force acting on the wall. The method is tailored to safety considerations. A parametric study of the force resulting from impact of a turbine of a military aircraft is discussed. It is shown that for safety considerations a simplified function force and time can be established.

24838 Force resulting from impact of fast-flying military aircraft upon a rigid wall. Drittler, K.; Gruner, P. (Technischer Ueberwachungs-Verein Rheinland e.V., Koeln (Germany, F.R.)). *Nucl. Eng. Des.;* 37: No. 2, 245-248(May 1976).

From International seminar on extreme load conditions and limit analysis procedure for structural reactor safeguards and containment structures; Berlin, Germany, F.R. (8 Sep 1975).

Using the method presented in ELCALAP Paper S1/6, a parametric study on the impact force of a fast-flying aircraft was carried out. The results show that the impact force is nearly insensitive to variations of relevant parameters. Therefore, only one force versus time curve may be used for safety considerations, etc.

24839 Aircraft impact on a spherical shell. Hammel, J. (Technische Univ. Darmstadt (Germany, F.R.). Inst. fuer Mechanik). *Nucl. Eng. Des.;* 37: No. 2, 205-223(May 1976).

From International seminar on extreme load conditions and limit analysis procedure for structural reactor safeguards and containment structures; Berlin, Germany, F.R. (8 Sep 1975).

For nuclear power plants located in the immediate vicinity of cities and airports, safeguarding against an accidental aircraft strike is important. Because of the complexity of such an aircraft crash the building is ordinarily designed for loading by an idealized dynamic load F(t), which follows from measurements (aircraft striking a rigid wall). The extent to which the elastic displacements of a structure influence the impact load F(t) is investigated. The aircraft is idealized by a linear mass-spring-dashpot combination which can easily be treated in computations and which can suffer elastic as well as plastic deformations. This 'aircraft' normally strikes a spherical shell at the apex. The time-dependent reactions of the shell as a function of the unknown impact load F(t) are expanded in terms of the normal modes, which are Legendre functions. The continuity condition at the impact point leads to an integral equation for F(t) which may be solved by Laplace transformation. F(t) is computed for hemispheres with several ratios of thickness to radius, several edge conditions and several 'aircraft' parameters. In all cases F(t) differs very little from that function obtained for the case of the aircraft striking a rigid wall.

24840 Review of procedures for the analysis and design of concrete structures to resist missile impact effects. Kennedy, R.P. (Holmes and Narver Inc., Anaheim, California 92801, USA). *Nucl. Eng. Des.;* 37: No. 2, 183-203(May 1976).

From International seminar on extreme load conditions and limit analysis procedure for structural reactor safeguards and containment structures; Berlin, Germany, F.R. (8 Sep 1975).

Concrete containment walls and internal concrete barrier walls are often required to withstand the effects of missile impact.

Potential missiles include external tornado generated missiles (steel rods, steel pipes, wooden poles, and automobiles), aircraft crash, and internal accident generated missiles (turbine blade, and steel pipe missiles resulting from pipe break). Impacting missiles can be classified as either 'hard' or 'soft' depending upon whether the missile deformability is small or large relative to the target deformability. This paper only deals with the effects of 'hard' missile impact. Missile velocities between 100 and 1500 ft/sec are emphasized. 'Hard' missile impact results in both local wall damage and in overall dynamic response of the target wall. Local damage consists of spalling of concrete from the front (impacted) face and scabbing of concrete from the rear face of the target together with missile penetration into the target. If damage is sufficient the missile may perforate or pass through the target. This paper reviews the various empirical procedures commonly used for determining penetration depth, perforation thickness and scabbing thickness for concrete targets subjected to 'hard' missile impact. Results obtained from these procedures are compared with test data results for low velocity impacts (200-1500 ft/sec). Design recommendations to prevent detrimental local wall damage are presented.

24841 Dynamic rupture analysis of reinforced concrete shells. Rebora, B.; Zimmermann, Th. (Ecole Polytechnique Federale, Lausanne (Switzerland)); Wolf, J.P. *Nucl. Eng. Des.;* **37**: No. 2, 269-297(May 1976).

From International seminar on extreme load conditions and limit analysis procedure for structural reactor safeguards and containment structures; Berlin, Germany, F.R. (8 Sep 1975).

Extreme dynamic loading conditions often require the rupture analysis of reinforced and prestressed-concrete structures. The study presented extends a method of analysis of dynamic loading conditions which has proven efficient for short-time loads. Another aim is to adapt the method to thin-walled structures. It is not sufficient to work only with plastic rupture and yield surfaces locally which are compared to the elastic distribution of the stress resultants; it is essential to account for the redistribution of the latter. The method proposed consists of discretizing the structure into isoparametric three-dimensional elements with 20 nodes for the concrete and one-dimensional bar elements with three nodes for the steel. The latter can also be handled with a 'smeared' two-dimensional membrane element. In compression a three-dimensional non-linear elastic constitutive law is introduced for the concrete, and a triaxial failure surface expressed in the stress invariants is used, determining cracking and crushing. Two- and three-dimensional cracking surfaces in which no components of stress are transmitted are accounted for. The possibility exists that, during the history of loading, cracks can close up again. For steel, a yield criterion is selected. The non-linear analysis is based on the concept of initial stress. Residual loads are calculated using information in Gauss integration points. The ultimate load is reached when the algorithm does not converge. The corresponding failure modes can be interpreted as those for which a state of equilibrium is no longer possible. The equations of motion are discretized in time, using an extension of the linear acceleration method.

24842 Some aspects of the reliability-based design of reactor containment structures. Schueller, G.I.; Schwarz, R.F. (Technische Univ. Muenchen (Germany, F.R.)). *Nucl. Eng. Des.;* **37**: No. 2, 299-305(May 1976).

From International seminar on extreme load conditions and limit analysis procedure for structural reactor safeguards and containment structures; Berlin, Germany, F.R. (8 Sep 1975).

A rotational procedure for the design of reactor containment structures is carried out within a probabilistic framework. Various risk concepts such as the return period, non-encounter probability and the reliability function are discussed. Internal load conditions caused by system failure such as LOCA pressure loads, and external load conditions caused, for instance, by impact due to aircraft crashes, external pressure waves and natural hazards such as earthquakes and severe storms, are described by extreme value distributions of the largest values of the Fisher-Tippett types. Statistical and physical arguments are given to support their applications. The occurrence of these rare events with respect to time is modeled by a Poisson process. The ultimate strength of a PWR containment structure for the steel (liner) shell is also modeled by an extreme value distribution (of the smallest values). As a good approximation the load action of the shell structure is determined by linear elastic analysis. The failure criterion considered here is that of reaching the ultimate tensile strength at one point of the structure. A numerical example of the reliability analysis of a steel shell structure under internal overpressure is carried out.

24843 Probability and containment of turbine missiles. Yeh, G.C.K. (Bechtel Power Corporation, Norwalk, California 90650, USA). *Nucl. Eng. Des.;* **37**: No. 2, 307-312(May 1976).

From International seminar on extreme load conditions and limit analysis procedure for structural reactor safeguards and containment structures; Berlin, Germany, F.R. (8 Sep 1975).

With the trend toward ever larger power generating plants with large high-speed turbines, an important plant design consideration is the potential for and consequences of mechanical failure of turbine rotors. Such rotor failure could result in high-velocity disc fragments (turbine missiles) perforating the turbine casing and jeopardizing vital plant systems. The designer must first estimate the probability of any turbine missile damaging any safety-related plant component for his turbine and his plant arrangement. If the probability is not low enough to be acceptable to the regulatory agency, he must design a shield to contain the postulated turbine missiles. Alternatively, the shield could be designed to retard (to reduce the velocity of) the missiles such that they would not damage any vital plant system. In this paper, some of the presently available references that can be used to evaluate the probability, containment and retardation of turbine missiles are reviewed; various alternative methods are compared; and subjects for future research are recommended.

24844 Heat exchanger system for the mediums liquid metal and water. Dreyer, S.; Kalkoffen, F.; Ratzel, W. (to Internationale Atomreaktorbau G.m.b.H. (INTERATOM)). German(FRG) Patent 1,501,544/C/. 13 May 1976. 4p. (In German).

2 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention refers to a heat exchanger system for the exchanging media liquid metal and water. It consists of several heat exchanger units connected in parallel whose liquid metal inlets and outlets are joined to inlet and outlet pipes for the liquid metal by means of distributors or manifolds. The system also contains safety relief vessels, designed as cylindrical horizontal pressure vessels, receiving the high-pressure amounts of liquid metal, water and reaction products appearing in case of ruptures of the heat exchanger tubes. In normal operation the relief vessels are separated from the pipes containing liquid metal by rupture discs. The significance of the invention is to keep the flow path to the nearest relief space closed by a rupture disc, as short as possible and this to keep the amount of liquid metal to be accelerated in case of damage as low as possible.

24845 Remarks on nuclear power plants. Crozon, M.; Gary, G.; Sene, M. *Bull. Union Physiciens;* **70**: No. 586, 1949-1960(Jul 1976). (In French).

The problems involved in the safety of PWR type nuclear power plants and reprocessing of the spent fuels from these power plants are discussed. As for safety, the accident considered as the most probable accident is the 'Loss of Cooling Accident' or L.O.C.A., safety depending then on the good working of the E.C.C.S. (Emergency Core Cooling System). The different stages in reprocessing the spent fuels from these power plants are briefly discussed, data given are concerned with a 1000MWe PWR in nominal operation, with a duty schedule of 100% for one year operation.

24846 Safety problems in fast reactors. Pharabod, J.P. *Bull. Union Physiciens;* **70**: No. 586, 1361-1367(Jul 1976). (In French).

The safety problems posed by fast reactors such as Super-Phenix are outlined. The most probable cause initiating the accident (power excursion) is a loss of flow of the primary sodium cooling the reactor core, with an impossibility in moving the control rods and then stopping the chain reaction. The nuclear excursion does not seem probable, but its evolution being unpredictable, the quality of the specified containment is discussed.

24847 Cooling and catching device for the melting or molten core of a nuclear reactor. Daublebsky, P. (to Kraftwerk Union, A.G.). German(FRG) Patent 2,459,339/A/. 1 Jul 1976. 9p. (In German).

2 figs. Available from Dt. Patentamt, Muenchen (FRG).

The invention relates to a cooling and catching device for the melting or molten core of a nuclear reactor in cases of failures of the emergency cooling system, sabotage or another accident causing a meltdown of the core, comprising a reactor vessel containing the reactor core, supported on fundamental parts of the containment, and a space arranged below the reactor vessel through which the melting reactor core can fall towards a containment floor.

24848 Vapor pressure studies over liquid uranium oxide and uranium plutonium oxide up to 5,000 K. Ohse, R.W.; Babelot, J.F.; Kinsman, P.R. (Commission of the European Communities, Karlsruhe (Germany, F.R.). European Inst. for Transuranium Elements); Brumme, G.D. (Technische Hochschule Darmstadt (Germany, F.R.). Inst. fuer Angewandte Physik). *Ber. Bunsenges. Phys. Chem.;* **80**: No. 8, 780-786(Aug 1976).

6 figs.; 2 tabs.; 30 refs.

The estimation of the energy release in a hypothetical fast breeder reactor core meltdown accident requires a detailed analysis of the disassembly process. Since the vapour pressure presents the ultimate shut-down mechanism, the required data are given by the equation of state of the irradiated fuel. The pressure over the ternary uranium-plutonium oxide was determined to log p(atm) = 7,966 - 28,137/T, yielding a heat of evaporation of $\Delta H_{sub(evap)}$ = 128.7 kcal/mol, fully consistent with the heat of sublimation of $\Delta H_{sub(sub)}$ = 148.4 kcal/mol below the melting point, and the heat of fusion of

19.4 kcal/mol. The corresponding equation for liquid UO_2 was determined as log p(atm) = 7.7 - 27,900/T, with a heat of evaporation of ΔHsub(evap) = 127.6 kcal/mol, again in consistency with the assessed data below the melting point of ΔHsub(sub) = 144.1 kcal/mol, and the heat of fusion of 17.7 kcal/mol. For this a new high-energy laser technique, including fast temperature recording in the microsecond range, was developed. The first quantitative measurements on $(U,Pu)O_2$ above 4,000 K were reported to the IAEA Symposium on Thermodynamics of Nuclear Materials in Vienna. The investigation of the total temperature range from 3,000 K to Tsub(c) = 7,560 K revealed two principle experimental difficulties, a liquid layer movement at temperatures below 4,000 K, and optical absorption due to increasing thermal ionisation above 5,000 K. A new double intensity laser pulse technique is presented, which allows the extension of measurements to below 4,000 K. In addition a multi-wavelength pyrometer technique has been developed to eliminate, and at a later stage to determine, spectral emissivities above the melting point, during laser heating within pulse times of micro and nanoseconds.

24849 What happened at Biblis. Mueller, W.D.; Hossner, R. *Atomwirtsch., Atomtech.;* **21**: No. 9;10, ang p. 1(Sep 1976). (In German).

Short communication only.

24850 New reactor safety test facilities at AEE, Winfrith. Johnstone, I. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). *J. Br. Nucl. Energy Soc.;* **15**: No. 4, 283-284(Oct 1976).

A new reactor safety test compound being constructed at Winfrith is briefly described. It is aimed at grouping together those UKAEA experiments in the field of reactor safety, which involve large scale plant and extensive instrumentation, so that facilities can be shared by a wide range of projects. Reference is made to tests in two cells, the thermal interaction rig and the containment modelling rig, which are now in operation.

24851 Redundant control circuits should be physically separated. Reisch, F. (Swedish Nuclear Power Inspectorate). *Nucl. Eng. Int.;* **21**: No. 249, 56-58(Oct 1976).

A comparison is made of US and Swedish safety requirements and their influence on control room design and cable layouts. More effort on checking and standardising active components is advocated.

24852 Theoretical and practical investment in the design of pipe whip prevention devices on pipes in nuclear power plants. Geiseler, H. (Technischer Ueberwachungs-Verein Norddeutschland e.V., Hamburg (Germany, F.R.). Abt. Berechnungen und Konstruktionsbeurteilungen). *Tech. Ueberwach.;* **17**: No. 10, 349-351(Oct 1976). (In German).

3 figs.; with refs.

According to the legal provisions applying to facilities subject to licensing, operational reliability is to be established in all required details. In order to protect the environment, the failure of pipes in systems under pressure is assumed, for instance, and the admissibility of the impacts is investigated. When exploring existing experience in design, in particular with regard to events in conventional power stations, precautions are made against faults in materials and against human error. Measures of a constructional or administrative kind resulting from this, in addition to quality control methods, increase plant safety.

ACCIDENT LIABILITY

REFER ALSO TO CITATION(S) 25734, 25736, 25738, 25740

24853 Act on compensation for nuclear damage, No. 332, of 19 June 1974. *Nucl. Law Bull.;* No. 15, 33-49(Apr 1975). (In English and French).

Translation of Danish Act No. 332 on compensation for nuclear damage.

Publication of the Act on compensation for nuclear damage enabled the Danish Government to ratify the 1960 Paris Convention and the 1963 Brussels Supplementary Convention on nuclear third party liability which form the basis of this new text. Therefore, the Danish Act lays down an absolute and exclusive third party liability regime for the operators of land-based nuclear installations. The operators liability is limited to 75 million Danish kroner for each nuclear incident. However, if this amount should be insufficient to compensate all damage, the State has agreed to additional financial compensation up to 120 million European Monetary Agreement units of account. Claims for compensation brought by victims of a nuclear damage against the operator liable are statute-barred after a period of 10 years from the date of the incident, or three years from the date when the victim had knowledge of the damage. Furthermore, this Act prescribes that the nuclear operator must take out insurance corresponding to his amount of liability.

24854 Price-Anderson Act (Indemnification and limitation of liability provisions of the Atomic Energy Act of 1954) as amended. Revised as of 31st December 1975. *Nucl. Law Bull., Suppl.;* No. 17, 3-15(Apr 1975). (In English and French).

In the United States, the legislative provisions on the third party liability of operators of nuclear installations are contained in the Atomic Energy Act of 1954 (Section 170). These provisions which are generally called the Price-Anderson amendment were inserted in 1957 and revised on several occasions. The latest revision was made in December 1975 and extends the duration of this legislation until 1st August 1987. It also provides for progressive replacement of the indemnification system by the Federal Government by a mechanism of financial contribution from nuclear industry in the form of deferred payments, in addition to cover of nuclear risk by insurance. Finally, this new system will raise the present ceiling of liability per nuclear incident which is fixed at 560 million dollars. By 1st August 1983, the Nuclear Regulatory Commission will have to submit to the United States Congress recommendations concerning the progress of this system.

ENERGY STORAGE

MAGNETIC

24855 (LA-UR—76-1978) Development and tests of superconducting magnetic energy storage systems components. Boenig, H.J.; Turner, R.D.; Hassenzahl, W.V. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 21p. (CONF-760975—1). Dep. NTIS $3.50.

From Frontiers of power technology conference; Stillwater, Oklahoma, United States of America (USA) (27 Sep 1976).

The major components of a superconducting magnetic energy storage system are briefly discussed. The electrical parameters of such a system are derived for constant power operation during magnet charging and discharging. A circuit to evaluate high current superconductors economically and nondestructively is described and test results for three different wires are presented. The second half of the paper deals with the design of an automated model SMES system which operates in a closed-loop power control mode. Test results of a twelve-pulse converter loaded with a pure inductance are given.

FLYWHEELS

24856 (Y—2072) Composite flywheel development, May 1—June 30, 1976. Huddleston, R.L.; Kelly, J.J.; Knight, C.E. (Oak Ridge Y-12 Plant, Tenn. (USA)). Jan 1977. Contract W-7405-ENG-26. 26p. Dep. NTIS $4.00.

A report is given summarizing Union Carbide Corporation-Nuclear Division's (UCC-ND's) composite flywheel program objectives and accomplishments for the period from May 1 through June 30, 1976. The necessity and urgency of national energy conservation is a well-recognized fact. Mechanical-energy storage, using rotating flywheels, is one of the few known methods for energy storage, and flywheels probably have the highest potential effectiveness for energy storage of any method now available. Initial application selected for the development of the composite flywheel is the heat engine/flywheel hybrid propulsion system for a vehicle, because of its high potential for the conservation of petroleum fuel in both the near and long-range time frames. Efforts have focused into key areas consistent with its experience base: state-of-the-art flywheel development, spin testing, and containment development. An operating performance goal of 20 watt-hr/lb (20 Wh/lb) energy density at an energy level of 0.56 kWh has been set by UCC-ND. The 20 Wh/lb goal encompasses both the composite flywheel and the hub that connects it to the shaft. It does not include the shaft. The goal exceeds the present performance of isotropic flywheels, and is also at the upper limit of current laboratory technology reported in the literature for composite flywheels. The thick rim with radial overwrap bands was selected as the initial design concept. Kevlar-49/epoxy was selected as the construction material, and the end of the design phase is near. A process for fabricating full-scale Kevlar-49/epoxy thick rims was developed, and full-scale rims were successfully wound. More detailed information is presented on the development plan for this budgetary period, and the present accomplishments with respect to: (1) flywheel design, analysis, and fabrication and (2) spin testing are discussed.

THERMAL

REFER ALSO TO CITATION(S) 24163, 24164, 24193

24857 (ORNL/TM—5682) Survey of technology for storage of thermal energy in heat transfer salt. Silverman, M.D.; Engel, J.R.

(Oak Ridge National Lab., Tenn. (USA)). 18 Jan 1977. Contract W-7405-ENG-26. 26p. Dep. NTIS $4.00.

The widespread use of nitrate-based fused salt mixtures as heat transport media in the petroleum and chemical process industries and in metallurgical heat-treatment operations has led to the development of satisfactory equipment for handling and containing these materials. A mixture known as heat transfer salt (HTS), which is composed of 40 percent $NaNO_2$, 7 percent $NaNO_3$, and 53 percent KNO_3 by weight, has been used commercially in large quantities as a heat transfer fluid. It has been suggested that this salt be used for storing energy as sensible heat in the temperature range 200 to 540°C (400 to 1000°F). The eutectic 54 percent KNO_3—46 percent $NaNO_3$ by weight known as "draw salt," which has undergone less testing but is more stable thermally and more attractive economically than HTS and has similar physical properties, may be a desirable alternative. Several specific energy storage applications, such as intermediate-load and peaking electric power, solar energy, and energy from fluidized-bed coal burners, are discussed. Long-term stability and corrosion data on these salts are presently available only to approximately 480°C. However, for the design and construction of energy storage facilities to operate over many years at temperatures up to approximately 540°C, long-term tests of thermal stability and corrosion are needed. Means for obtaining such information are proposed.

BATTERIES

DESIGN AND DEVELOPMENT

24858 (CONF-760866—2) **Design and testing of lithium/iron sulfide batteries for electric vehicle propulsion.** Chilenskas, A.A.; Bernstein, G.J.; Graae, J.E.A.; Hornstra, F.; Slawecki, M.A.; Kolba, V.; Ivins, R.O. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 33p. Dep. NTIS $4.00.

From 4. international electric vehicle symposium; Dusseldorf, German, Federal Republic of (F.R. Germany) (31 Aug 1976).

A program to develop high-performance batteries for use in electric automobiles and for storing off-peak energy for load leveling in electric utility systems is described. The batteries for vehicle propulsion consist of cells with a central positive plate containing FeS_2 and two facing negative plates containing Li—Al alloy. The electrolyte is the LiCl—KCl eutectic which has a melting point of 352°C and requires the cells to be operated at temperatures between 350 and 450°C. Prismatic cells 13 cm on a side and 2 to 4 cm thick were fabricated. Laboratory cells demonstrated a capacity at the 10-hour rate of about 120 Ah at 1.5 V, which corresponds to a specific energy of about 150 W-hr/kg. A battery testing laboratory was established which contains equipment for charging and discharging the cells in a mode that simulates the operation of the cells in an electric vehicle battery. Equipment was developed for equalizing the charge in an array of cells; it was tested successfully with lead—acid batteries as well as Li—Al/FeS_2 batteries. A cell charge equalization system suitable for incorporation in a vehicle propulsion battery was also developed. Calculations and experimental measurements were made to determine resistances of the various internal and external cell and battery components. Designs were developed for a 30 kWh vehicle battery suitable for driving a small four-passenger vehicle. The battery design is based upon the use of 160 prismatic sub-cells, 13 x 20 cm, which are arranged in two parallel rows. Adjacent sub-cells are connected in series. The battery is contained in an enclosure which is designed to minimize heat loss during idle periods and remove excess heat generated during operating periods. 10 figures, 4 tables.

24859 (EPRI-EM—266) **Development of sodium—sulfur batteries for utility application. Annual report.** Chatterji, D. (General Electric Co., Schenectady, N.Y. (USA). Research and Development Center). Dec 1976. 248p. Dep. NTIS $8.00.

Work during the past year on the development of a sodium—sulfur battery system for bulk storage of energy is described. Two initial cell/module/system designs are discussed. The cell in these preliminary designs consists of many individual beta-alumina tubes used as the separator between single sodium and sulfur compartments. Heat conduction experiments were made and a complete thermal analysis of the system is given. Progress on construction of a 45-tube cell is given. A comparative cost analysis of the above multitube designs with designs consisting of bundles of cylindrical single-tube cells indicated that the latter approach would probably have a cost advantage. A statistical analysis of the effects of failure or change in performance of individual cells or modules and a study on optimization of the system cost were performed. Improvements in the microstructure, grain boundary resistance, and surface uniformity of the ceramic electrolyte resulted in cells with lower resistance and no sign of ceramic degradation after more than six months of continuous charge and discharge at constant current. Over 300 Ah/cm^2 was obtained with no limit evident, and the surface resistance problem was solved. Improvements in the design of the graphite current collector resulted in consistently high cell capacity. The utilization of sulfur achieved increased up to a value of 95%. A few cells using stainless steel containers showed no decrease in either cell capacity or cell resistance up to the present extent of testing (190 cycles for one cell) or to the time of failure due to seal failures. Supporting research included corrosion studies on container materials, sodium motion and defect structure in beta alumina, pressure—temperature stability of β and β''-alumina, and the effects of grain orientation on the electrical properties of beta-alumina. 60 figures, 26 tables.

24860 (LA—6632-MS) **Electrochemical heat engines.** Elliott, G.R.B. (Los Alamos Scientific Lab., N.Mex. (USA)). Dec 1976. Contract W-7405-ENG-36. 11p. Dep. NTIS $3.50.

Any nearly reversible electrochemical cell reaction involving a significant entropy change can, in principle, be made the basis of a heat engine. Usual Carnot cycle efficiency limits apply, and the appropriate thermodynamic equations are very similar to those for Ford's sodium heat engine or for usual heat-to-work cycles in physical chemistry textbooks. Electrochemical heat engines produce electrochemical rather than mechanical work, and mechanical motion is limited to valve and switching actions as the heat-to-work cycles are performed. Practical devices will presumably use molten or solid electrolytes at high temperatures, and one or more reactions in the cycle will generate a gas at high temperature which can be condensed at a lower temperature with later return of the condensate to the electrochemical cell for further steps of the cycle. Sodium, potassium, and cesium look particularly promising as the working gases for higher-temperature cells (above 600 K), and halogen gases or volatile halides may be useful with lower-temperature heat sources. Carbonates and halides look promising as molten electrolytes, and solid electrolytes may be useful as separators. 3 figures, 3 tables.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 24967

24861 **Performance characteristics of solid lithium—aluminum alloy electrodes.** Gay, E.C.; Vissers, D.R.; Martino, F.J.; Anderson, K.E. (Argonne National Lab., IL). *J. Electrochem. Soc.;* **123**: No. 11, 1591-1596(Nov 1976).

Lithium—aluminum alloy electrodes have shown a great deal of promise for meeting the performance requirements of negative electrodes in batteries for off-peak energy storage in utility networks and for vehicle propulsion. To develop negative electrodes that meet the cell performance goals, the effects of a number of variables on the lithium—aluminum electrode performance were determined. Investigations were conducted to determine the effects of volume fraction electrolyte in the electrode, electrode thickness, fabrication technique, lithium concentration in the Li—Al alloy, and current collector in the electrode. Electrochemically formed Li—Al electrodes that are 0.32 cm thick, have an electrolyte volume fraction of 0.2 in the charged state, and contain about 2 percent stainless steel wire current collector demonstrated the performance goals for the negative electrodes in a Li—Al/FeS_2 electric automobile battery. For electrode thicknesses greater than or equal to 0.64 cm, vibratorily loaded pyrometallurgical Li—Al electrodes with porous metallic current collectors demonstrated the highest lithium utilization and capacity density over a wide range of discharge current densities and met the performance goals for negative electrodes in a Li—Al/FeS_2 off-peak energy storage battery. (8 figures, 3 tables)

24862 **Engineering analysis of shape change in zinc secondary electrodes. I. Theoretical.** Choi, K.W. (Univ. of California, Los Angeles); Bennion, D.N.; Newman, J. *J. Electrochem. Soc.;* **123**: No. 11, 1616-1627(Nov 1976).

Shape change, the redistribution of active material over the zinc electrode surface as a result of cell cycling, is hypothesized to be caused by convective flows driven primarily by membrane pumping. A mathematical model is formulated based on the convective flow hypothesis for the zinc—silver oxide secondary cell. The numerical solutions predict redistribution of zinc material over the zinc electrode, fluid flow rates, and variations of current distribution and cell potential with the number of cycles. These calculated results can be compared to experimental results. The results suggest that shape change can be eliminated if the convective flow in the zinc electrode compartment parallel to the electrode surface is stopped. (11 figs.)

24863 **Engineering analysis of shape change in zinc secondary electrodes. II. Experimental.** Choi, K.W. (Univ. of California, Los Angeles); Hamby, D.; Bennion, D.N.; Newman, J. *J. Electrochem. Soc.;* **123**: No. 11, 1628-1637(Nov 1976).

Experimental data on zinc—silver oxide secondary cells were used to evaluate the convective flow hypothesis on the cause of shape change of zinc electrodes. A cell with flooded, vented electrodes designed to allow "normal" convective flow was studied.

Zinc electrodes cycled in this cell showed extensive material redistribution in accord with predictions based on the hypothesis. Measured volume average fluid flow rates for this cell were also in agreement with predicted values. Zinc electrodes cycled in a second cell, designed to minimize convective flow in the zinc electrode compartment, showed virtually no active material redistribution. (8 figures)

APPLICATIONS

REFER ALSO TO CITATION(S) 24858, 24993

ENERGY MANAGEMENT AND POLICY

24864 Retrieval of geoscience information. Proceedings of the tenth annual meeting of the Geoscience Information Society held October 21st, 1975, in Salt Lake City, Utah. Falls Church, VA; Geoscience Information Society (1976). 197p. GIS Secretary, c/o American Geological Inst., 5205 Leesburg Pike, Falls Church, VA 22041 $12.00.

Symposium I, The Location and Retrieval of Energy Resource Information, consists of eight papers, namely: Data Tagging in Information-Accessing Services Containing Energy-Related Data; Considerations for the Design of a National Information Center for Renewable Energy Sources; Experimental Design of Information Systems for Crises Management; Development of a Geothermal Thesaurus; Technical Information Programs of the Federal Energy Administration; National Geothermal Information Resource; Data Base for Surface Mining and Land Reclamation; and The ERDA Technical Information Program. Two papers cited, but not given at the conference were Environmental Sciences Data for Energy R and D (Fossil Fuels) and Development of a Computer-Based Energy Integrated Vocabulary. At Symposium II, Data Retrieval for the Student Research, and the Environmentalist, seven papers are included, namely: Teaching Library and Literature Search Strategy to Geology Students; Water Resources Literature Cited in Wisconsin Department of Natural Resources Publications (1964-1973); GeoRef Developments (machine readable bibliographic data base for geology); The Awareness of Relevant Water Resources Literature; Environmental Policy Making and Information; A Comparison of Journal Articles in Environmental and Laboratory Science; and The MINT System; A Scheme for Organizing a Small Map Collection. (MCW)

24865 Jahrbuch fuer Bergbau, Energie, Mineraloel und Bergbau 1976/77. (Yearbook for mining, energy, petroleum and chemistry 1976/77). Reintges, H.; Schorn, P.; Schroedter, E.; Willing, H.G. (eds.). Essen, Germany, F.R.; Glueckauf (1976). 1369p. (In German). With figs. and tabs.

A short survey of the present energy situation in the Western World is the introduction to one of the most comprehensive works of reference on energy economy ever published. The main part of the book contains short descriptions of all the firms and institutions working the energy sector in the FRG, with an alphabetical index of these firms and institutions and a register of persons. This information is supplemented by statistical data on production and consumption. International companies and business connections go beyond the geographical limits of the FRG, so that this yearbook also contains quite a number of European firms and organizations.

SYSTEMS STUDIES AND TOTAL ENERGY

REFER ALSO TO CITATION(S) 24872, 24874, 24882, 24888, 24934, 24935

24866 Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976). 449p. (CONF-750846—). ASCE, 345 E. 47 St., New York, NY 10017 $10.00.

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

Abstracts were prepared for thirty-two of the thirty-four papers presented at the eight sessions of the conference. One article, the Impact of Nuclear Fuel Cycle Centers on Shipping Special Nuclear Materials and Wastes, by J. O. Blomeke has already appeared in ERDA Energy Research Abstracts (ERA). Following four papers in an introductory session, the sessions are entitled: Land use: Water Supply and Cooling, Waste Products, Ecology, Socio-Economic Problems, Licensing, and Public Participation. (MCW)

24867 Objectives of conference on energy complexes. Goodman, A.S. (Polytechnic Inst. of Brooklyn, NY). pp 1-5 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

The premise of the conference was that a key element in the U.S. energy future is provision of additional electric-generating capacity. Even after practicing measures of energy conservation, the need will still exist for additional capacity. The additional capacity considered at the Conference was in the form of energy complexes of 4,000 MWe or greater. In Session I, "Introduction," the speakers discuss energy needs of the future and how energy complexes fit in this picture; define in greater detail what is meant by an energy complex; and discuss examples of energy complexes that have been built or are planned. Session II, Land Use, deals with the basic problems of regional and local siting, from the standpoints of the private sector, state government, the consulting engineer, and the power utility. Sessions III and IV deal with the civil and environmental engineering involved in siting power stations, and Session IV discusses the ecological impacts of energy complexes. Sessions VI, VII, and VIII consider the problems of energy complexes interfacing with the social, political, and legal institutions of the country and with the public. The final session, No. IX, was a summary session. (MCW)

24868 Existing and planned energy complexes. Broome, K.R. (Gilbert Associates, Inc., Reading, PA). pp 24-45 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

Five representative energy complexes were selected to be investigated in order to show the comparative suitability of each type with respect to major variable characteristics. The five are: Conowingo, Lower Susquehanna River, Pennsylvania; Keowee-Toxoway, South Carolina; Pennsylvania Energy Park, N. E. Pennsylvania; Hanford, Richland, Washington; and Multi-Purpose Offshore Industrial Port Island, offshore New Jersey. Characteristic variables of impact on existing population, fresh water consumption, reliability and stability, transmission losses, potential for accidental release of unauthorized acquisition of fuel, and portential savings in construction cost are examined for each complex. (MCW)

24869 No future without nuclear energy. When can new energy systems find application. - ASA seminar in Porz. *VDI (Ver. Dtsch. Ing.) Nachr.;* **30**: No. 23, 25(Jun 1976). (In German).

Ten non-university institutions, which are members of the 'Grossforschungseinrichtungen (AGF)' (large-scale research facilities), deal with the Applied Systems Analysis Programme (ASA) which was started two years ago. It is the aim to analyze future applications of new or improved technologies, to estimate the consequences of their application and to investigate the relation between technical economic and social developments so as to support and advise both research planning of the AGF members and official authorities with the results of these analyses and outlooks. The ASA activities focus on four long-term studies in the energy, traffic, raw-material, communication and associated fields accompanied by studies in the fields of applied economic science and social research. First results were released on the occasion of an ASA status seminar in the Porz-Wahn research center of the Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt (DFVLR), which is member of AGF, said results including findings in the field of future energy problems.

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 24905, 24918, 24925, 24927, 24929

24870 (UCID—3757) U.S. employment for 368 input-output sectors for 1963, 1967, and 1972. Merrill, D. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 30 Jun 1975. Contract W-7405-eng-48. 205p. Dep. NTIS $8.75.

By utilizing an input-output model, the Bureau of Economic Analysis (BEA) publishes at 5-year intervals complete input-output tables for the U.S. economy, disaggregated to several hundred industrial sectors. In addition, a large number of state governments have shown sufficient interest that they too are regularly publishing input-output tables for their particular states. An extremely interesting application of the model lies in its ability, in principle at least, to predict changes in employment resulting from changes in economic activity. One may consider labor as an additional input to each industrial sector, and one may calculate a labor coefficient for each industry as the ratio of employment to gross output in that industry. In Appendix E of this report estimates are presented of U.S. employment, in jobs (full plus part-time, including self-employed and unpaid

family workers) for the years 1963, 1967 and 1972; military personnel are excluded. The data are broken down to show (a) wage-and-salary employment, and (b) non-wage-and-salary employment, including self-employed workers and unpaid family workers.

24871 Wettbewerbliche und strukturelle Aspekte einer Zusammenfassung von Unternehmen im Energiebereich (VEBA/Gelsenberg). (Competitional and structural aspects of a combination of companies in the energy field). Baden-Baden, Germany, F.R.; Nomos (1975). 184p. (In German).

With figs. and tabs.

The work is an experts' opinion on the economic, especially competitional consequences of a fusion of two large German companies in the field of energy, VEBA AG and Gelsenberg AG.

24872 Scope of socio-economics considerations. Schmidt, E.J. (Stone and Webster Engineering Corp., Boston). pp 272-273 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

The general development of socio-economic activities in Stone and Webster Engineering Corporation is briefly described. Activities have changed from a public-relation type activity to one involving the public-at-large and ultimately the regulatory agencies. Engineers now work with economists, urban planners, demographers, tax specialists, and transportation planners. The involvement of political and regulatory officials at the local and state level has increased. The activities encompassed by socio-economic studies have also become popular topics for intervention at public hearings. The author quotes from the NRC guideline for preparation of environmental reports, Regulatory Guide 4.2 and from the Rules of Procedure for compliance with Article 8 of the New York State Public Service Law to define the scope of socio-economic considerations. Reference is also made to a report of the Federation of Rocky Mountain States, RESOURCE CITY, ROCKY MOUNTAINS, describing a hypothetical boom town growth resulting from massive energy developments. (MCW)

24873 Community development implications of energy complex construction. Cavanagh, C.R. (Stone and Webster Engineering Corp., Denver). pp 280-291 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

This paper presents a preliminary examination of the community development implications of construction of a mid-size (28,000 MW) energy complex. It does not purport to offer an in-depth analysis of community development problems and issues, nor does it recommend a course-of-action. It does, however, identify the general requirements for major community facilities and services that will result from energy complex development, discuss the role of the utility company in community development, and examine principal alternate community development options and their implications.

24874 Conowingo—Peach Bottom energy complex: financial, legal, and public relations aspects. Johnson, W.H. (Philadelphia Electric Co.). pp 292-311 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

Experiences of developing this complex over the past 40-odd years are reviewed. Changes in emphasis, proliferation of regulations, changing financial climate and public involvement, and their resultant effect on providing an essential energy service to the public are outlined. It is noted that the conception of this present energy complex is defined by two eras, separated by a period of 35 years. The initial development occurred at a time stressing national growth and affluence. In the 1960s that continuing growth of electric service demand prevailed. Then the period of contestation of growth began. The three broad areas of concern involved public relations, legal considerations, and financing. The order of these is deliberate since it is well demonstrated that the effect of one category of problems begets the succeeding one. The author then discusses what the impact of the experiences of the utility will have on the future, and he does believe that the public and the Congress are finally realizing that coal and uranium are emerging as the near-term solution to the energy crisis. (MCW)

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 24873, 24894, 25308

24875 (CONF-751096—, pp 199-209) **Decision making in the regulation of chemicals.** Brooks, E.M. (Environmental Protection Agency, Washington, DC). Jul 1976.

From Conference on the environmental impact of water chlorination; Oak Ridge, Tennessee, United States of America (USA) (22 Oct 1975).

In Environmental impact of water chlorination.

Some brief remarks are made regarding the regulatory aspects of environmental pollutants and toxic materials.

24876 (UCRL—51930(Vol.1)) **Environmental effects of energy production and utilization in the U.S. Volume I. Sources, trends, and costs of control.** Newkirk, H.W. (comp.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 May 1976. Contract W-7405-ENG-48. 481p. Dep. NTIS $12.50.

Volume I deals with sources (what the emissions are and where they come from), trends (quantities of emissions and their dispersion with time), and costs of control (what it takes in time, energy, and money to meet minimum standards). Volume II concerns itself with the public health effects of energy production and utilization. Volume III summarizes the various techniques for controlling emissions, technological as well as economic, social, and political. (For abstracts of Vols. II and III, see ERDA Energy Research Abstracts, Vol. 2, Absts. 5764 and 5670, respectively) Each volume is divided into sections dealing with the atmosphere, water, land, and social activities—each division indicating a particular sphere of man's environment affected by energy production and use. The sources of information that were used in this study included textbooks, journal articles, technical reports, memoranda, letters, and personal communications. These are cited in the text at the end of each subsection and on the applicable tables and figures.

24877 Current state of environmental policy. Hart, G. (U. S. Senate, Washington, DC). *J. Energy Dev.;* **2**: No. 1, 13-22(Aut 1976).

New strategies for setting and reaching national energy goals are needed to counter the resistance of those who feel environmental protection policies have a negative impact on the economy and energy problems. The best strategy will capitalize on our economic system's responsiveness to cost and price signals rather than ask people to change their lifestyle. Those who feel the cost of cleaning up the environment is too great an economic burden overlook the fact that only two percent of the gross national product will be involved and the estimated effect on the consumer price index will be negligible. Comparisons of costs to benefits of relieving the damage of pollutants do not indicate any inflationary impact. While environmental protection standards may have accelerated some plant closings, there is no evidence that total jobs are lost and, in fact, environmental efforts may create some jobs. The energy cost of meeting pollution standards appears to be small, although energy costs have increased. The record of U.S. efforts for pollution control in the 1970s indicates that, while destruction has been halted in some areas, regulations have been inconsistent and have focused too strongly on short-term efforts. A strategy is needed that offers incentives to manufacturers to use less scarce material in their products and to customers to seek out these products. Such techniques as a solid-waste-disposal pollution tax would encourage recycling, conserve pimary sources, and generate revenues. (DCK)

24878 EPA jurisdiction over well injection under the Federal Water Pollution Control Act. Eckert, A.W. (Environmental Protection Agency, Washington, DC). *Nat. Resour. Lawyer;* **9**: No. 3, 455-465(1976).

The Federal Water Pollution Control Act (FWPCA) of 1972 does not include underground waters as navigable, yet it establishes a national system of permits for discharges into navigable waters that must control the disposal of pollutants into wells. Although the National Pollutant Discharge Elimination system (NPDES) grants states the right to issue permits for discharging pollutants into wells, it never delineates the authority of the Environmental Protection Agency administrator from that of the state. The courts are likely to be called upon to resolve questions of authority. Amendments to clarify the issue have been debated in Congress and have revealed the confusion over the definition of navigable and ground waters. If the courts should hold that FWPCA lacks authority to impose conditions on surface water permits for ground water purposes, the National Environmental Policy Act (NEPA) may have the authoriy because of past court decisions. The Safe Drinking Water Act, which sets a state and Federal system for regulating underground injection of fluids, does not preclude court resolution. (DCK)

24879 Regional and local siting problems with emphasis on overall environmental impact: introduction. Dewey, C.A. Jr. (Duke Power Co., Charlotte, NC). pp 46-47 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

In considering future energy supplies, the total environment must be considered for siting energy parks. Land, air, and water quality plus meteorological and population density are varaiables for consideration as well as the socio-economic-political impact of tax base lost to cities and states when the Federal Government provides the energy site. (PCS)

24880 Some factors affecting land use for energy centers. Kornberg, H.A. (Electric Power Research Inst., Palo Alto, CA). pp 48-58 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

This paper seeks to develop a perspective of facts and forecasts related to land use for electric power generation. Tables are included comparing power plants fueled by coal and by uranium. (PCS)

24881 Role of geotechnical engineering in land use planning. Hirschfeld, R.C. (Geotechnical Engineers, Inc., Winchester, MA). pp 65-72 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

In designing and selecting a site for a large energy complex, engineering considerations will likely include such diverse components as heavy structures, dams, and underground structures. Because geologic conditions affect cost, safety and environmental impact, the designer must consider geotechnical constraints in choosing optimum site and layout. (PCS)

24882 Nuclear energy center impact on land use. Jenkins, F.A. (Duke Power Co., Charlotte, NC). pp 73-79 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

For the seven nuclear energy centers (NECs) indicated for the six southeastern states (North and South Carolina, Florida, Alabama, Virginia, and Georgia), excess land of over 700 square miles for transmission lines is required as compared with dispersed generating sites—more than 100 square miles per NEC. Land use for cooling ponds may not be greatly different for NECs as compared with dispersed generating sites but a lake of approximately 200 square miles for a center will disrupt highways, railroads, and other services and have significant effect on a large region. There are only a few areas, aside from the seacoast which could support the consumptive water use required for a NEC without creating serious water problems. Flexibility in planning—as a land use consideration— would be lost with the NEC concept. The ability to change generation sites and transmission lines as changing load patterns occur would be lost. A change in reactor technology may require significantly different land area and site arrangement, making a NEC site inadequate or unusable. Land requirements for the NECs will far exceed land requirements for dispersed generation sites. This discussion does not consider fuel fabrication, reprocessing and waste disposal. From the point of view of land use, the author feels that dispersed generation siting, as presently done by utilities in most of the states, is far superior to the NEC concept.

24883 Inland site location in the Northeast with emphasis on water supply needs. Freeman, C.; Dixon, J.H. (Tippetts-Abbett-McCarthy-Stratton, Consulting Engineers, New York). pp 92-130 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

Three river basins—the Hudson-Mohawk, the Delaware, and the Susquehanna—were studied in detail for different development purposes, and over a sufficient period of time to witness many changes in planning objectives, concepts, and public and political attitudes in water resources development. These changing concepts have resulted in major modifications in the criteria and procedures for conducting comprehensive river basin studies dealing with definitive project siting. These studies are still being pursued on a continuing basis. This paper presents ideas on how to cope with these changing conditions. Also based on the gained experience, revised criteria and procedures for solving new water resources development problems, such as identifying areas where cooling water requirements for large energy parks can be developed, are discussed. 27 references.

24884 Regional impacts from water consumption and heat disposal in river basins and estuaries. Engman, E.T. (NUS Corp., Rockville, MD). pp 131-146 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

This paper stresses the regional impact of heat disposal and consumptive use of water in river basins and estuaries. The cumulative effect of many users is considered for river basin organization and laws. Especially considered are the effects from using evaporative cooling for existing and new power plants. (PCS)

24885 Water supply for energy complexes in water-short regions. Stamm, G.G. (Bureau of Reclamation, Washington, DC); Kauffman, K.O. pp 147-170 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

This paper deals with water required for energy generation complexes, concentrating on coal mining and electric power generation. In addition to primary activities, added municipal wastes, industrial wastes, decreased oxygen content, increased temperature, heavy metal content, and toxic materials, bacteria and salinity must be considered as indirect energy-related demands on water resources. It concludes water resources are the key to energy development and life quality. (PCS)

24886 Wastewater reuse aspects of energy complexes. Dea, S.J. (NUS Corp., Rockville, MD). pp 171-180 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

Several advantages and disadvantages associated with energy complexes are discussed in relation to planning and effectuating water reuse. Such planning has been made urgent and necessary by the water pollution regulations recently enacted. The high degree of treatment required for discharge renders the product too valuable to throw away; reuse is inherently advantageous. A systems approach toward all use, reuse, and disposal cycles for water is advocated. (PCS)

24887 Solid waste management at energy complexes. Berg, D.R. (Environmental Protection Agency, Washington, DC). pp 201-210 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

The hypothetical energy complex examined by the author contains one coal-fired power plant and one fired by synthetic gas produced from coal (1000 MWe each). The city of 400,000 population is located near all the facilities, including one open pit coal mine (10.8×10^6 Te/yr) and one coal gasification plant (Squires process: 157 Btu/cu ft gas; $5.01 \times 10''$ cu ft/yr). The recovery and reuse of all energy and materials from the complex are calculated and described. In the case examined, at the present rates of recovery (15% for ash and sludge, 71% for MSW, and 100% for sewage sludge), a one-fourth reduction in disposal of nonmining, noncoal cleaning wastes will result. The remaining volumes can likely be absorbed in the mining reclamation activity. It is concluded that planners can design new energy complexes to take advantage of much of the solid wastes produced. (MCW)

24888 Air pollution factors in the planning of energy complexes. Smith, M.E. (Smith-Singer Meteorologists, Inc., Amityville, NY). pp 211-218 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

From a meteorological standpoint, energy complexes should not present air pollution problems beyond present technical control capabilities. The most pressing need is accurate data on quantity, health and environmental effects, and generation mechanisms. Too much speculation from too few data has undesirable effects. (PCS)

24889 Terrestrial impact of energy complexes. Dinger, B.E. (Oak Ridge National Lab., TN). pp 219-234 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

Perhaps the singular most important item concerns the much greater land area requirements for large energy centers, relative to those posed by dispersed sites and/or smaller centers. The increased transmission rights-of-way necessary as a result of aggregating numbers of generating facilities into a limited number of sites comprise a major fraction of total land area demand. Some benefit may be realized with advanced transmission technology, but equipment improvements cannot be expected to have a material effect on reliability requirements which specify multiple ties with other production and transmission centers. In essence, therefore, the use of centers, either nuclear or fossil, stands to intensify any existing problems regarding rights-of-way acquisition and attendant environmental characteristics. A commitment to the energy center concept must balance increased land area demands, and consequent ecological impacts against economic, social, or other benefits likely to be gained by way of aggregating the nation's power production facilities within a limited number of large sites.

24890 Impact of energy complexes on freshwater environments. Jensen, L.D. (Ecological Analysts, Inc., Baltimore). pp 235-249 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

This paper attempts to suggest areas of data collection effort that appear relevant to monitoring programs at steam-electric generating stations. Time has permitted only the most general comments regarding the nature of sampling efforts in rivers, lakes, reservoirs, and other freshwater lacustrine ecosystems. Site-specific features of each generating station warrant a detailed review of data requirements and sampling protocol before initiating the extensive and inherently costly studies that appear to be suggested by various EPA and NRC guideline documents. Because of the complexity of such studies, environmental program personnel should consult and develop specific sampling programs in concert with various EPA and NRC regional staffs in order to prevent misunderstandings and conflicts that may be anticipated as a result of the development of these data programs at new and expanded energy complexes.

24891 Marine ecological impacts associated with power plant activities. Copeland, B.J. (Central Power and Light Co., Corpus Christi, TX); Moseley, F.N. pp 250-271 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

Numerous organisms can be impinged on power plant traveling screens and this impingement rate can be of some concern. Although there are no specific guidelines for the construction and/or operation of power plant intake structures, some suggestions are worthy of comment: (1) When possible, power plants located on estuaries should be located in such a way that the intake canal avoids major migratory routes of estuarine organisms. (2) Power plant screens should be located along a shoreline rather than at the end of a long intake canal so that fewer organisms are entrained in the canal. (3) Traveling screen wash systems should be constructed so that organisms collected on the screens could be transported back to a body of water with minimum damage. (4) Where feasible, once-through cooling lakes can be utilized for potentially commercial harvest with stocking occurring from organisms collected on traveling screens. (5) Fine mesh screens described earlier appear to allow higher survival rates than conventional screens. With proper planning in design and operation of intake structures at power plants, they can be located and operated in a coastal environment and do minimum damage to the environment.

24892 Study of aridity. *Mosaic;* **8**: No. 1, 1-52(1977).

A Mosaic special.

This special issue of Mosaic addresses the generic problems of aridity and desertification—and in the final chapter discusses the proposed cautious interventions "containing rather than dramatically reversing desertification, protecting the land where possible from the worst incursions of man and nature, while using technology gently to minimize adverse effects and get as much as possible out of the fragile soil." This is in contrast to the 1950s, when most of the bright visions involved bringing water from where it is to where is isn't to "make the deserts bloom." Of the other six chapters, the first five discuss the basics of deserts or arid regions, showing the aridity maps of the world and presenting the effects of climate and weather and the biology of aridity. The sixth chapter, The American Experience, after tracing the failures over the first 100 years in handling the fragile water-poor ecosystems of the western U.S., discusses present research programs developed for this purpose—many of them sponsored by the National Science Foundation. The Kenya-based United Nations Environment Program will hold an international conference on problems associated with desertification in August 1977. (LMT)

ENERGY RESOURCES

24893 Energy future and the chemical fuels. Bockris, J.O'M. (Flinders Univ. of South Australia, Bedford Park). *Pure Appl. Chem.;* **47**: No. 1, 25-39(1976).

From 25. International congress of pure and applied chemistry; Jerusalem, Israel (6 Jul 1975).

An account is first given of the origin of present chemical fuels, with particular reference to the lastingness of coal. Methods of estimation of these fuels are discussed and the greenhouse effect arising from the burning of coal is described. Consideration is then given to methods available for extending the uses of chemical fuels, including interfacing them with new inexhaustible, clean energy sources. Finally, accounts are given of the Hydrogen Economy and of the production of chemical fuels from wind energy in massive wind belts. The paper includes references to the part that nuclear power was expected to play in future energy policy. Problems of breeder reactor development and the safety and management of plutonium and radioactive wastes are discussed.

24894 Energy and environmental impacts of materials alternatives: an assessment of quantitative understanding. Purcell, A.H. (George Washington Univ., Washington, DC); Smith, F.L. *Resour. Recovery Conserv.;* **2**: No. 2, 93-102(Dec 1976).

The literature was reviewed to determine which materials may require the least energy for manufacture and use, which may have the least detrimental effect on the environment, and what effect recycling may have on both factors. There is substantial agreement as to the benefits of recycling on environmental quality and conservation, although there are some important variations in the attempts to quantify the benefits. There is less agreement as to the relative energy consumption and effect on the environment of using materials. This is due chiefly to the substantial number of variables that enter into the evaluations as well as the difficulty in weighting their relative effects. The development of environmental profile analysis—in which subimpacts are weighted before being combined into aggregate impact measurements—appears to be a promising approach to making the analysis of energy and environmental factors more meaningful. 39 references.

RESEARCH AND DEVELOPMENT

REFER ALSO TO CITATION(S) 24918

24895 Provincial resource development research policy. Flock, D.L. (Univ. of Alberta, Edmonton). *J. Can. Pet. Technol.;* **15**: No. 3, 32-36(1976).

In Alberta, there is an abundance of oil, natural gas, and coal. But only a small portion of the Alberta oil sands and coal resources are commercially accessible to surface-mining techniques. It is quite apparent that some in-situ technological breakthrough will be required, which will mean a concerted research effort at the provincial level. It is the purpose of this paper to present certain concepts and recommendations for a coordinated provincial resource development research policy for the Province of Alberta. Research as discussed in this paper covers basic and applied research and development. (MCW)

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 24074, 24106, 24128, 24320, 24322, 24328, 24494, 24501, 24698, 24700, 24866, 24874, 24882, 24888, 24915, 24916, 24935

24896 Anatomy of nuclear dissent. Hosmer, C. *Electr. Perspect.;* No. 5, 20-23(1976).

According to former Congressman Hosmer, anxiety over safety and proliferation underlie some nuclear apprehension, but nuclear dissent in America today also embraces a quite separate category of opponents consisting of people disillusioned with some aspects of society, possibly distrustful of its institutions, and seeking for the country a quite different life style. The strategies of Ralph Nader are cited: he won his fight against Detroit's corporate giants by alarming the public of the shortcomings of the Corvair automobile. An interview with Nader, as head of the anti-nuclear movement, is reviewed. The purpose here was not to make a cost-benefit analysis of the no-growth, low-energy philosophy, or to evaluate the ethical considerations underlying strategies to forward it. The purpose was, rather, to: (a) postulate that a movement may exist to effect material changes in American life styles, using the nuclear issue as a diversionary stalking horse; and (b) to suggest that public discussion of the no-growth future, and the indirect strategy for imposing it, could move the United States nuclear industry off its defensive posture. (MCW)

24897 Stellungnahmen zu offenen Problemen der Kernenergienutzung. Ergaenzungen zur Auswertung der Oeffentlichen Anhoerung des Innenausschusses des Deutschen Bundestages. (Statement on unsolved problems of nuclear energy utilization). Feuerborn, A. (comp.). Berlin, Germany, F.R.; Schmidt Verl. (1976). 59p. (In German).

Supplement to no. A 39 'Contrasting issues and problems related to the utilization of nuclear energy'.

The present book might be a possible step on the way to inform the public about the peaceful use of nuclear energy and its eventual effects without giving any personal opinions. The author tries to show additionally the points which need to be explained after the hearing of the internal committee of the German Bundestag on 2nd/3rd December 1974: (1) The biological-medical and ecological aspects; (2) Technical aspects of safety; (3) Tasks and organization forms of the control to guarantee protection and safety; (4) Economic aspects; (5) Legal aspects; (6) Integration of nuclear energy in the technical world of man, risks of nuclear energy and how far they are justifiable, alternatives to nuclear energy. Institutions, firms and personalities were asked to give their opinion to these questions. Each point also contains the opinions and their evaluation.

24898 Nuclear energy in Britain. Reference pamphlet 28. London, UK; HMSO (1976). 44p.

Pound1.

The development of the peaceful uses of nuclear energy in Britain, the organisations responsible for this development and the evolution and extent of the nuclear power programme are described. An account is also given of radioisotopes and their uses; current nuclear research, health and safety measures; and training arrangements.

24899 Planning for nuclear power in the Philippines. Results and role of the feasibility study and manpower requirements. Ibe, L.D. (Philippine Atomic Energy Commission, Diliman, Quezon City). *Philipp. At. Bull.;* **1**: No. 1, 6-10(Jan 1976).

The events that led to nuclear power introduction in the Philipines are traced starting from: the creation of the National Science and Development Board and Philippine Atomic Energy Commission in 1958 under R.A. 2067; recruitment of young engineers, chemists and other scientists and their training for the different specialized fields of nuclear energy; the creation of an inter-organizational Ad-Hoc Committee on Nuclear Power Study; initiation of a UNDP-IAEA supported Pre-Investment Study on Power Including Nuclear Power in Luzon in early 1964; enactment of R.A. 5207, the Philippine Nuclear Liability Act in 1968; second feasibility study in 1971; siting study by PAEC, NPC and MERALCO engineers; technical and economic study; organizational and financial study; and investment report. Upon receipt of the results of the feasibility studies on 31 July 1973, the President of the Philippines decided on the immediate implementation of the first nuclear plant project by the National Power Corporation (NPC). Licensing and regulation as well as manpower training with the aid of regional or international training agencies will be undertaken by PAEC.

24900 Large-scale use of nuclear power. A Faustian bargain. Temple, R. (Sydney Univ. (Australia). Dept. of Physical Chemistry). *Curr. Aff. Bull.;* **52**: No. 12, 4-17(May 1976).

Arguments are presented against the use of nuclear energy under four main headings: contamination of the environment, reactor hazards, nuclear blackmail, danger of nuclear war. It is argued that the toxicity of plutonium and the storage and disposal of radioactive wastes present serious problems for the use of nuclear energy. Doubts are also expressed about the radioactivity level produced by fusion reactors.

24901 Survey on the state of nuclear power industry for fiscal 1974. *Genshiryoku Chosa Jiho;* No. 29, 1-66(May 1976). (In Japanese).

Results of the survey on the nuclear power industry in Japan for one year up to March 31, 1975 are presented. Carried out each year by JAIF, the survey covering expenditures, proceeds and employes aims to grasp the status of the nuclear power industry, thereby contributing to solid growth of the industry. Of the total 1,165 companies (mining and manufacturing 1,091, electric power 11 and trading 63), 760 answered the questionnaire. Expenditures and proceeds in the mining and manufacturing industry and expenditures in the electric power industry have risen significantly due to inflation. The total expenditures are 650,000 million (42% up); the proceeds in mining and manufacturing enterprises are 279,400 million (72% up) and the dealings by trading firms are 248,100 million (17% up). The total number of employes is 33,307 (17% up).

24902 Brief report on nuclear energy topics. Frewer, H. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). *Brennst.-Waerme-Kraft;* **28**: No. 9, 374-376(Sep 1976). (In German).

The present state of nuclear power plant development is briefly reported on. This development is characterized by an increasingly critical attitude of the general public, by the export of nuclear power plants to Brazil and Iran, and by a modified HTR programme in the FRG.

24903 Nuclear energy in Belgium. Report of the van Beraad commission on nuclear energy. *Atoomenerg. Haar Toepass.;* **18**: No. 10, 258-261(Oct 1976). (In Dutch).

The report relates to the studies of the van Beraad Commission on nuclear energy in Belgium. Overall energy requirements have been forecast for postulated growth rates of 2.5%, 4% and 5.5% g.n.p. Locations of existing plants and progress made are also quoted, the main centers being Doel, Mol, Tihange and Chooz. Reactor types surveyed include PWR, BWR, Magnox, AGR, HTGR and fast breeders. Siting problems were also surveyed and a number of peripheral items such as fuel cycle management, safety, ecology, control and inspection.

24904 State of affairs in the European Nuclear Industry. Camps, M.E.H. *Elektrotechniek;* **54**: No. 10, 646-648(Oct 1976). (In Dutch).

The European situation concerning production of nuclear reactors and their heavy components and of fission materials is reviewed as well as the facilities for enrichment of uranium or treatment of waste fuel. The European breeder reactors are discussed, and the position of the Netherlands on the subjects above is indicated.

CONSERVATION

REFER ALSO TO CITATION(S) 24702, 24894, 24933

24905 Consumer adaptation to energy shortages. Curtin, R.T. (Univ. of Michigan, Ann Arbor). *J. Energy Dev.;* **2**: No. 1, 38-59(Aut 1976).

Consumers can learn to lower expectations and effect energy savings while maintaining a sense of well-being and improving the efficiency of their energy consumption. Results of a survey of personal reactions to the 1973 energy shortages shows that most people reduced consumption for gasoline, heat, and electricity below the previous year; less than 20 percent reported no conservation effort. A year later there was a substantial residue of conservation mindedness, although the rate of consumption had increased. People who viewed the need to conserve as a national and global problem were more inclined to curb their personal consumption. A majority of respondents felt further conservation efforts would be difficult, indicating that populat support backed by analysis of conservation barriers is needed. Profiles of the respondents indicate that past experiences of conservation made it easier to adapt to new demands. Future hardships could lead to a polarization of the population according to adaptibility and a need for provisions to help those least able to adapt. Youth and education were found to facilitate conservation. Efforts reflected the consumer's confidence in government policies and opportunity for financial benefit. (DCK)

24906 Voluntary industrial energy conservation. Progress report 4. Washington, DC; Department of Commerce (1976). 65p. Federal Energy Administration, Washington, DC.

Continuing improvement has been shown in the energy conservation results of industries participating in the joint Commerce-FEA Voluntary Industrial Energy Conservation Program (VIECP). This report, for the first half of 1976, shows both increased production levels and for those industries which had been affected by low utilization of capacity, such as industrial chemicals, significantly better energy conservation results. Included in this publication are 33 reports from 34 industry groups which have established formal energy conservation and reporting systems. Substantive industrial associations reports for Air-Conditioning and Refrigeration; Expanded Shale, Clay and Slate; Fertilizer; Forging; Grocery Manufacturers; Clay Pipe; Lime; Pharmaceutical Manufacturers; Refractories; and Rubber Manufacturers appear for the first time in the report. Work with these associations continues with the objective of developing full-fledged energy measurement and conservation systems in

order to be consistent with the applicable requirements of the Energy Policy and Conservation Act (PL 94-163).

24907 Zur Notwendigkeit einer staatlichen Energieeinsparungspolitik. Ein kritischer Ansatz. (To the question whether there is a need for a governmental energy-saving policy. A critical approach). Schmitt, D.; Schuermann, H.J.; Plluge, W. Muenchen, Germany F.R.; Oldenbourg (1976). 114p. (In German).

With tabs; refs. and app.

The authors conclude no need for a governmental energy saving policy exists.

24908 Law for the saving of energy in buildings. *Kohle Heizoel;* **29**: No. 8, 14-18(Aug 1976). (In German).

Text and discussion of the law for energy saving in buildings of July 22, 1976 is presented.

24909 Purchasing strategies for reducing the direct consumption of energy. Tether, I.J. *ECP Rep.;* No. 7, 1, 20-38(Sep 1976).

Draft chapter from the book Energy Conservation and Buildings.

The book, of which this a draft chapter, is to be published by Ballinger Publishing Co., Spring 1977. Saving a government's energy can save that government's money. This relationship ranks the strategies in this chapter among the most popular energy-conserving strategies. While purchasing strategies presented in subsequent chapters may find their cost justification in less-tangible benefits, such as encouraging private citizens to conserve energy, the strategies in this chapter can usually be fully justified on the basis of saving money. Furthermore, they often set an example for the private sector, stimulate the development of energy-efficient technology, and curtail spread of environmental degradation, which often accompanies energy production and consumption. The purchasing strategies outlined in this chapter would increase the energy efficiency of government-owned commodities and buildings, resulting in savings which will increase with the cost of energy. To the extent that savings exceed the cost of implementing a strategy, the strategy will save not only energy, but money. Readers with the power or responsibility over public purchasing should carefully consider the adoption of these strategies. (MCW)

24910 Design features, shading, and orientation for energy conservation. Thompson, G.P. *ECP Rep.;* No. 7, 1-20(Sep 1976).

Draft chapter from the book Energy Conservation Strategies for State and Local Procurement and Operations.

The book, of which this is a draft chapter, will be published by Ballinger Publishing Co., Spring 1977. State governments can use specific legal techniques to encourage or require builders and owners to save energy. Most of the techniques could be applied to any building in any region. Other chapters in the book deal with energy conservation problems so individual that no general rules can be formulated. This chapter deals with a third kind of challenge: how to encourage energy conservation by mandating building design changes. The search is for laws that force the builder to examine his site carefully, to consider ways to increase the shading of his building in the summer, and to work with, rather than against, the natural forces of prevailing winds, sun, and reflections from bodies of water. This chapter addresses how to control the discretion granted to an agency—how regulations can be made specific enough to survive judicial scrutiny. One theme developed is that the minimization of energy use is best accomplished without prescribing the exact solutions or mix of features that will do a job. The goal should be variation of execution with uniformity of result. (MCW)

24911 Resource recovery systems for non-recappable rubber tires. Search, W.J.; Ctvrtnicek, T.E. (Monsanto Research Corp., Dayton, OH). *Resour. Recovery Conserv.;* **2**: No. 2, 159-170(Dec 1976).

The disposal of non-recappable scrap rubber tires is a problem shared by virtually every nation in which motorized vehicles (i.e., cars, trucks, and buses) play an essential or critical role in everyday life. The problems in scrap tire disposal are discussed and several possible solutions employing currently available technology are reviewed. A brief analysis of the technical and economic feasibilities of the various processing options is presented. 28 references.

24912 Efficient energy use and well-being: the Swedish example. Schipper, L.; Lichtenberg, A.J. (Univ. of California, Berkeley). *Science;* **194**: No. 4269, 1001-1013(3 Dec 1976).

Examination of the energy and GNP statistics for the most industrialized countries indicates a large spread in the ratio of energy use per unit of GNP. This article compares energy use in the United States, one of the countries with a high energy/GNP ratio, with that in Sweden, a country which in 1971 used approximately 60 percent as much energy as the United States to generate each dollar of GNP. Sweden was chosen not only because of its low energy/GNP ratio, but also because the GNP per capita is essentially the same in both countries. Moreover, much of the economic activity and many of the demographic features in Sweden are similar to those in the United States. Thus, evaluating the differences in energy utilization between these two countries may illuminate strategies for saving energy. Studies of energy conservation in the United States indicate that the more important of these strategies, taken together, could reduce energy consumption 25 to 40 percent, while lowering pollution, reducing capital requirements for energy production, and generally raising employment. But the interrelationships among economic inputs (including energy) within an economy are complex. Thus, examination of an economy similar to that of the U.S. but requiring substantially less energy may provide guidance in understanding the total effect of energy conservation. Physical characteristics, economic activity, food, health and education, and conveniences such as appliances and automobiles are indicators that are compared for Sweden and the U.S. Energy consumption in all sectors are compared and some specific data are provided for transportation comparisons. (MCW)

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 24702, 24865, 24867, 24880, 24926, 24930

24913 America's energy futures. Canfield, M. Jr. (General Accounting Office, Washington, DC). pp 6-18 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

A brief review of energy consumption in the United States reveals that between 1950 to 1965 the annual growth rate was 3.5 percent; between 1965 to 1973, the annual growth rate was about 4.5 percent. Thus, total energy consumption has more than doubled in a period of about twenty years; per capital energy consumption increased at about 40 percent in the same period. At the same time, domestic energy production was decreasing, showing only a 3 percent annual growth rate. The concern then, hinges on the assumptions about demand levels. The author then summarizes what people are after when they think about energy as revealed in a study by the Ford Foundation's Energy Policy Project (complete discussion in the book, A Time to Choose, EAPA 1:0085). Five values that people seek are identified as: (1) provide a reliable and flexible supply of energy allowing for no unexpected shortages; (2) provide energy at the lowest total cost to society; (3) avoid economic and regional inequities in such concerns as employment, income, and supply measures; (4) safeguard and improve the quality of the environment; and (5) minimize international problems. The policy tools employed to achieve them are discussed. (MCW)

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 24878, 24907, 24908, 24920, 24921, 24922, 24926, 24928

24914 Energy development on the public domain: Federal/state cooperation and conflict regarding environmental land use control. Shapiro, M.E. *Nat. Resour. Lawyer;* **9**: No. 3, 397-439(1976).

Federal and state discord may be lessened as a result of balances struck between Federal interest in energy resource development and affected state interest in assuring environmental quality. The Department of the Interior assumes that Federal leasing of western coal and oil shale lands will increase resource availability without being hampered by too stringent environmental protection laws. Western states, however, have pressured the Federal government for a greater voice. In many cases state laws are more strict than Federal regulations and there is pressure for states' rights to prevail. Federal energy development programs include gas, oil, oil shale, and coal in general and development on the public domain as authorized by the Mineral Leasing Act. The Bureau of Land Management (BLM), which is responsible for 450 million acres or nearly one third of the nation's land, has functioned in land disposal rather than in management in the past. Current BLM plans will be to classify lands to determine optimum land use, then proceed to a management plan that will include evaluation and public interaction. States are becoming aware of the need to make public comment and take stands on these Federal proposals. States have retained jurisdictional authority over federally-held lands to the extent of police power, and some legislative and proprietary rights. Examples of land use legislation of western states illustrate the respective authority granted to Federal and state governments and raise the possibilities of state obstruction of Federal land management. (DCK)

24915 State government view of energy complexes. Harrington, J.E. (Dept. of Natural and Economic Resources, Raleigh, NC). pp

59-64 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

The author reviews the experience in North Carolina dealing with energy complexes. That state is committed to nuclear power and siting of these facilities is being planned. The author says land-use planning is only a partial solution and proceeds to list three major steps he thinks should be taken toward managing the social and economic impacts. 1. State governments need to be brought into the siting process at the earliest possible time, but state governments should become a qualified partner. Most state governments will need to improve competence within their agencies and to reorganize the way they are doing some processes. 2. A great deal more research needs to be done on the potential socio-economic impacts of utility siting. It is imperative, if the U.S. is to take a fair reading of the energy complexes question, that knowledge of potential socio-economic impacts be on the same level as engineering and environmental protection. 3. All states, particularly those planning nuclear parks, should undertake serious study of the energy park question: the needs of each state are different, but if state government and industry do not cooperate, the Federal government will have to step in. (MCW)

24916 Referenda on nuclear energy. *At.-Inf.;* No. 8;9, 3-4(1976). (In German).

A nationwide petition for a referendum on nuclear energy is not possible according to Basic Law; these referenda could only be introduced with a majority amending the constitution (Bundestag and Bundesrat). In some Laender these referenda, or petitions for them, can take place. However, on account of the Atomic Energy Act the legislation power with regard to nuclear law has ceased for the Laender (the exception being the competence reserved for the Land authorities). Possible laws regulating or obstructing the peaceful uses of nuclear energy issued by the Laender would have to be declared as irreconcilable with Federal law by the Federal Administrative Court and thus these laws would not be applicable.

24917 Authority of public utilities to raise aspects of the public interest in an assured energy supply in proceedings for provisional protection of rights according to sub-section 5 section 80 of the VwGO. Buedenbender, U. *Energiewirtsch. Tagesfragen;* **26**: No. 8, 439-446(Aug 1976). (In German).

55 refs.

24918 New York version of ERDA envisions key role in bolstering state economy. *Energy Res. Rep.;* **2**: No. 12, 8-11(Dec 1976).

Interview with N. Richard Werthamer, Chairman, New York State Energy Research and Development Authority.

New York has established a State Energy Research and Development Authority to interact with the federal ERDA in developing energy proposals and bringing the state its fair share of research and development money. Economic considerations will have top priority in matters of energy pricing and development of private industry. The chairman of the state's largest utility, the Power Authority, serves as a member of the new organization. New York also has a counterpart to the Electric Power Research Institute (EPRI). After operating for less than one year, the authority is presently involved in a dairy farm wind power project that will tie in with the area electric grid and a solar demonstration project. Emphasis will be placed on alternative energy sources, conservation, efficiency, and environmental effects of energy technology. Tax-exempt bonds are issued for pollution control, mainly scrubbers, but not for generating capacity. It is anticipated that financing will be available for solar and efficiency equipment also. The New York authority is not as broad as that of California, which also handles siting and conservation planning. Regional authorities are recommended because of varying situations around the country which should be introduced into national ERDA planning at an earlier stage than is the current practice. (DCK)

FOSSIL FUELS

REFER ALSO TO CITATION(S) 24865, 24895, 24936

COAL

REFER ALSO TO CITATION(S) 23906, 23911, 23912, 23913, 24328

24919 Chances of the German coal mining industry. Bund, K. (Gesamtverband des Deutschen Steinkohlenbergbaus, Essen (Germany, F.R.); Ruhrkohle A.G., Essen (Germany, F.R.)). *Bergbau;* **27**: No. 5, 144-146(May 1976). (In German).

4 figs.

The role of German coal mining on an international scale is dealt with. The possible markets for German coal, especially coking coal, are studied, and some consequences are drawn with regard to mining.

PETROLEUM

REFER ALSO TO CITATION(S) 23991, 23994, 24020, 24023

24920 (FEA/S—76/487) **Strategic Petroleum Reserve. Final environmental impact statement. Volume I.** (Federal Energy Administration, Washington, D.C. (USA)). Dec 1976. 706p. (FES—76-2(Vol.1)). Federal Energy Administration, Washington, DC.

The Federal Energy Administration proposes to implement the Strategic Petroleum Reserve, Title I, Part B of the Energy Policy and Conservation Act of 1975 (P.L. 94-163). The purpose of the Reserve is to mitigate the economic impacts of any future interruptions of petroleum imports. One hundred fifty MMB of oil will be stored by 1978 in the Early Storage Reserve, and five hundred MMB will be stored by 1982 under the full program. It is proposed that crude oil be stored underground in solution-mined salt cavities, and conventional mines. However, modification to the proposal may require that petroleum products be stored aboveground in tanks. This programmatic EIS identified particularly sensitive environmental parameters that are being investigated in more detail in specific EIS's for each candidate site. The most sensitive parameters appear to be water quality and geology. The adverse impacts that could result from the program include the degradation of surface water quality from construction runoff, increased dredging, and more frequent oil spills. In addition, brine disposal associated with solution mining salt cavities will increase the salinity of the receiving waters, whether underground saline aquifers or small portions of the Gulf of Mexico. Changes in water quality will have a short-term impact on aquatic organisms in local areas. Use of large quantities of ground water for developing salt cavities (although not now anticipated) could cause some surface subsidence over water storage areas, slow salt water encroachment, and movement of near-surface geologic faults. Hydrocarbon emissions from fill and withdrawal operations may cause temporary localized violations of the Federal standard, but no long-term adverse impact on air quality would result. Alternatives considered are delineated.

24921 (FEA/S—76/488(Vol.2)) **Strategic Petroleum Reserve. Final environmental impact statement.** (Federal Energy Administration, Washington, D.C. (USA)). Dec 1976. vp. (FES—76-2(Vol.2)). Federal Energy Administration, Washington, DC.

This volume includes comments on the programmatic environmental impact statement of Vol. I (FEA/S-76/487) from Federal, state, and local agencies and private industry.

24922 (FEA/S—76/501) **Strategic Petroleum Reserve. Final environmental impact statement for Bayou Choctaw salt dome.** (Federal Energy Administration, Washington, D.C. (USA)). Dec 1976. vp. (FES—76-5). Federal Energy Administration, Washington, DC.

The Federal Energy Administration proposes to implement the Strategic Petroleum Reserve (SPR), Title I, Part B of the Energy Policy and Conservation Act of 1975 (P.L. 94-163) through the development of a 99 million barrel crude oil storage facility at the Bayou Choctaw salt dome. The purpose of the SPR is to mitigate the economic impacts of any future interruptions of the petroleum imports. Under the initial phase of the SPR, referred to as the Early Storage Reserve (ESR), one hundred fifty million barrels of oil will be stored by 1978. Of the different types of storage facilities, existing solution-mined salt dome cavities are among the most attractive for petroleum storage because of the relative low cost of bulk storage and the extreme geological stability of rock salt masses. The Bayou Choctaw site, a salt dome with existing cavities located in Iberville Parish, Louisiana, has been identified as a candidate site for the ESR because it offers the advantage of large storage capacity, easy access to the distribution network, and a relatively short preparation period. A summary of environmental impacts and adverse environmental effects is given and alternative energy storage sites are listed. (From Summary)

24923 (NP—21625/1) **Proposed 1976 Outer Continental Shelf oil and gas lease sale, Gulf of Mexico: OCS sale 44. Final environmental impact statement. Volume 1.** Berklund, C. (Bureau of Land Management, Washington, D.C. (USA)). 1976. 405p. Bureau of Land Management, Washington, DC.

Sixty-one tracts of 254,488 acres (102,991 ha) of OCS land have been proposed for leasing action; the tracts are located offshore Texas and Louisiana. If implemented, this sale was tentatively scheduled to be held in November 1976. All tracts offered pose some degree of pollution risk to the environment. The risk potential is related to adverse effects on the environment and other resource uses which may result principally from accidental or chronic oil spillage. Each tract offered is subjected to a matrix analyses tech-

nique in order to evaluate significant environmental impacts should leasing and subsequent oil and gas exploration and production ensue. Alternatives to the proposed action are to hold the sale in modified form; withdraw the sale; or delay the sale. An alternative with the proposed action is for the government to explore before leasing. Comments for Federal, state, and private institutions have been requested. (MCW)

24924 (NP—21625/2) **Proposed 1976 Outer Continental Shelf oil and gas lease sale, Gulf of Mexico: OCS sale 44. Final environmental impact statement. Volume 2.** Berklund, C. (Bureau of Land Management, Washington, D.C. (USA)). 1976. vp. Bureau of Land Management, Washington, DC.

Maps of the tracts of 254,488 acres (102,991 ha) of OCS land proposed for leasing (Sale No. 44) in the Gulf of Mexico off the coast of Texas and Louisiana are in the packet. The sale was tentatively scheduled for November 1976. The information given in the visual graphics include lease status, recreation, historic and archaeological resources; geologic and geomorphic features; upland soils and bottom sediments; and undersea features, endangered wildlife, and natural vegetation. (MCW)

24925 **Non-OPEC oil supply and implications for OPEC's control of the market.** Sakbani, M.M.; Van Belle, J.J. (Federal Reserve Bank of New York). *J. Energy Dev.;* **2**: No. 1, 76-85(Aut 1976).

Market forces are operating to counter the success of the Organization of Petroleum Exporting Countries (OPEC) and increase the effects of non-OPEC supplies. Foreign-exchange pressures will affect OPEC prices after 1980 as other sources assume a larger market share. For the remainder of the 1970s OPEC surpluses will peak at nearly $200 billion and will be concentrated by those member nations which are the last to feel the pressure of foreign exchange earning because they can under-produce and match supply with demand. All OPEC nations will not be able to restrain their own demand for imports unless the low-absorbers can provide subsidies. New discoveries and production of non-OPEC oil after 1980 and the development of alternate energy sources will require new responses from OPEC. Since much of the new oil discovery will occur in OPEC or Third World countries, OPEC may be able to retain its present position. (DCK)

24926 **Short-term petroleum supply and demand forecasting: an applied approach.** Alt, C.B.; Bopp, A.; Lady, G. (Federal Energy Administration, Washington, DC). *J. Energy Dev.;* **2**: No. 1, 86-102(Aut 1976).

A short-term forecasting model was developed by the Federal Energy Administration to assess six-month petroleum supplies and conservation potential and to forecast the impact that deregulation of oil prices would have on future supply and demand. Computers were used in an automated analysis system to analyze economic relationships and assess alternative scenarios. The system provides accurate, flexible, and rapid forecasts of value to policy makers, who need to be able to evaluate a large number of options in a short time. Existing models were not useful because they were designed to simulate long-term equilibrium properties of the energy market. The short-term system introduces weather and seasonal factors, supply disruptions, availability of alternate fuels, and current demand. The goal of the short-term model, to minimize the impact of shortfalls, followed the 1973 Arab oil embargo. Details of the model's evolution are included in the article. (DCK)

24927 **Economic and financial implications of the dismemberment of U.S. oil companies.** Johnson, W.A. (George Washington Univ., Washington, DC); Messick, R.E. *J. Energy Dev.;* **2**: No. 1, 103-131(Aut 1976).

Written for the United States Treasury Department.

The probable economic and financial costs of legislating divestiture for the eight major oil companies are examined to determine what consequences divestiture will have for the American consumer and economy. The most serious impact will be an increased dependence on imported oil and vulnerability to price and supply changes. The capacity of vertical integration to reduce risk and maintain stability has attracted investors in the past. Provisions of divestiture legislation, however, will cause bondholders to develop a new relationship, making it difficult for the industry to either attract the debt capital it needs for expansion or be able to pay the higher interest rates. Equity markets will also be disrupted, which will lower security prices and be felt by a large segment of the population. The industry will not only find it difficult to form capital, but it will be reluctant to re-invest in units that stand to be divested. Research and development programs will be curtailed during the transition period. Long-run reduction of research and development efforts will result from the loss of interaction that is available in an integrated industry. This will reduce the innovation needed to develop energy sources. Problems for foreign nationals will arise if the estimated $3.5 billion debt of subsidiaries is subject to foreign litigation and if joint ventures lose the stability of integrated backing. (DCK)

24928 **Refinery siting from the regulator's viewpoint.** Stickney, W.E. (Environmental Impact Office, EPA, Boston). *Nat. Resour. Lawyer;* **9**: No. 3, 529-533(1976).

State, local, and Federal review of site decisions for refineries will develop better decisions than after-the-fact reviews to determine compliance. For example, if local zoning regulations are incorporated at the initial planning stage, subsequent hearings and injunctions might be avoided. Coordinated regional and local government units which have been involved in two proposed New England sites have been able to draw on academic as well as expert consultants, state as well as federal agencies, and citizens groups. These different groups collected information and communicated with each other through the interagency procedural structure set up by the federal government. Frontier areas where little energy facility development exists will be especially benefited by the requirement for coordination because alternatives, restrictions, and potential actions will be better defined. Although several levels of review do not guarantee better decisions, simultaneous application and review with a comprehensive environmental impact statement will increase communication and awareness. Concurrent hearings, for example, will be more efficient and effective. (DCK)

24929 **Impact of the public on proposed offshore oil terminal and refinery.** King, J.P. pp 276-279 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

The author briefly describes the dilemma of petroleum supplies being brought ashore in the Northeast. Presently, the coastal harbor at Boston receives small, antiquated tankers, and experiences oil spills daily. After studying eleven alternative methods for petroleum to be brought to the Northeast, the deep water offshore terminal seemed the most appropriate. A massive opposition arose to even an attempt to investigate a deep water port and refineries. The study has not been completed. In a search for an answer to why this opposition, the author concludes "leadership, or perhaps more appropriately, the absence of responsible leadership compounded by confusion that has been propagated and perpetuated by self-indulgent rhetoric or self-righteous propaganda that helps no one or no cause." (MCW)

24930 **Energie - die geplante Krise. Ursachen und Konsequenzen der Oelknappheit in Europa. (Energy, the planned crisis. Causes and consequences of the oil shortage in Europe).** Chevalier, J.M. Frankfurt am Main, Germany F.R.; Fischer Taschenbuch Verl. (Feb 1976). 169p. (In German).

With tabs. and refs. Translated from French: Le nouvel enjeu petrolier.

Taking the history of petroleum as a background, the author deals with the present oil crisis. In this connection he also discusses the oil policy of the great combines and of the countries producing petroleum. The following topics are dealt with in 5 chapters: 1) the world market for petroleum until 1970, 2) the crisis of the period 1970-73 and its consequences, 3) the countries producing petroleum, 4) the countries exporting petroleum; and 5) the great energy combines.

24931 **North Sea '76.** Harms, K. *Oel;* **14**: No. 10, 270-279(Oct 1976). (In German).

1 fig.; 2 tabs.

The petroleum and natural gas extraction from the North Sea shelf, the activities of the British National Oil Corporation, BNOC, the granting of off-shore licenses, and exploration successes of the petroleum companies are reported on. Petroleum and gas extraction from British fields is dealt with in detail, and the importance of Great Britain as Western Europe's biggest oil production country is pointed out. The main petroleum and natural gas fields in the North Sea, their capacity, and their annual output are presented in tabular form.

NATURAL GAS

REFER ALSO TO CITATION(S) 23991, 24030, 24031, 24033, 24923, 24924

24932 **Firm deliveries, firm curtailments, and firm requirements of interstate pipeline companies based on Form 16 Schedule 1A reports. Summary by state of actual firm deliveries, firm curtailments, and firm requirements for 1975—1976 Winter compared to projected for 1976—1977 Winter.** Washington, DC; Bureau of Natural Gas (1976). 7p.

The Federal Power Commission released this report summarizing on a state-by-state basis the actual net natural gas requirements, curtailments, and deliveries for 1975-76 winter compared with those projected for 1976-1977 winter. It should be noted that the projected data are based on occurrence of normal weather, and supply-demand factors projected as of April 1976. It should be further noted that 1975-1976 was a warmer than usual heating season. (MCW)

24933 Conservation investments by gas utilities as a gas supply option. Rosenberg, W.G. (Federal Energy Administration, Washington, DC). *Public Util. Fortn.;* **99**: No. 2, 13-21(20 Jan 1977).

A proposal is made for gas utilities to promote gas conservation by financing gas efficiency programs for residential customers. The program would include insulation to Federal standards, automatic thermostat controls to lower gas consumption at night, and furnace modification to improve seasonal efficiency. Costs for the program would be included in rates. The option to sell conservation gas to new or priority customers would be determined by public utility commissions. National energy goals would benefit through improved housing and minimizing the force of higher prices as an incentive for conservation. Benefits from the program include an increase in available gas, lower heating bills, employment opportunities, business opportunities for utilities, new gas for new customers, eliminating the need for Federal subsidy, and reducing the need for imported oil and gas. A seven-year period is suggested for implementing the proposal with costs recovered from all customers in the system. Regulatory changes are needed to allow utilities to recover conservation expenses by changing rate structures and to avoid conflict with anti-trust and other laws. (DCK)

HYDROGEN AND SYNTHETIC FUELS

REFER ALSO TO CITATION(S) 24150, 24153

ELECTRIC POWER

REFER ALSO TO CITATION(S) 24702, 24866, 24867, 24868, 24873, 24874, 24879, 24880, 24885, 24889, 24890, 24891

24934 Energy complexes: conceptual arrangements. Gunwaldson, R.W. pp 19-23 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

The author considers water power, tidal power, geothermal solid wastes, fossil fuels, and nuclear as feasible and competitive for energy complexes. An energy complex (or energy park as some prefer to call it) may be any one of a number of things: a cluster of electric generating units of the same or of different energy conversion types; a cluster of energy processing units of the same or different types; or a cluster of electric generating units with an energy processing unit or a group of such units. The conceptual arrangement of any such energy complex will reflect all of the many requirements being satisfied today in siting individual power and energy processing plants—plus the effects of much greater public attention and participation. The siting of an energy complex will evolve from the same iterative process involving detailed study of the technical, environmental, economic and political aspects of power plant siting. (MCW)

24935 Water and electric power in the Pacific Northwest. Limpert, F.A. (Bonneville Power Administration, Portland, OR). pp 80-91 of In Civil and environmental engineering aspects of energy complexes. Goodman, A.S. (ed.). New York; American Society of Civil Engineers (1976).

From Engineering foundation conference on civil and engineering aspects of energy complexes; Henniker, New Hampshire, USA (5 Aug 1975).

See CONF-750846—.

The Columbia River and its tributaries, as used primarily in the production of power, are investigated. Each of the ingredients for determining the hydroelectric power potential of the Columbia River basin are examined. After considering the streamflow and associated flow, storage, and hydroelectric power plant installations, the firm amount of power that can be generated is then estimated. It was realized in about 1968 that additional capacity would be necessary for the Pacific Northwest, and the Hydro-thermal Power Program began to be formulated with formal approval being given by the Secretary of the Interior in 1968 and by the President in 1969. Implementation of the Federal portion of the program was initiated by Congress in the Public Works Appropriation Act of 1970 and approved through 1981 by the Public Works Appropriation Act of 1971. Construction of additional transmission lines by Bonneville Power Administration is discussed. Then to meet energy demand in the 1980s, the construction of planned nuclear installations will be of importance. The progress of nuclear power plant and related programs at the Hanford Reservation is reviewed briefly. (MCW)

ELECTRIC POWER GENERATION

REFER ALSO TO CITATION(S) 24884, 25308

24936 Worthiness of natural gas power stations to be promoted within the framework of the 'Kohlegesetz' (coal act). *Energiewirtsch. Tagesfragen;* **26**: No. 10, 620-621(Oct 1976). (In German).

The higher administrative court in Muenster has decided by its ruling of 26th March 1976 - IV A 791/74 - (not effective in law) regarding the coal act of 15th May 1968/18th December 1975 that a project cannot be considered normally as worthy of promotion in the economic sense according to article 32 paragraph 2 No. 1 of the coal act, if by granting the investment premium the direct utilization of an energy carrier which competes with black coal is supported. Thus the erection or expansion of a natural gas power station in black coal mining regions would not lead regularly to a permit being granted according to article 32 section 2 No. 1 of the coal act. The main grounds upon which the judgment was based are presented in full.

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 24876, 24906, 24909, 24910, 24912

UNCONVENTIONAL SOURCES AND POWER GENERATION

REFER ALSO TO CITATION(S) 24918, 24965

SOLAR

REFER ALSO TO CITATION(S) 24150, 24184, 24187

GEOTHERMAL

REFER ALSO TO CITATION(S) 24212, 24218, 24231, 24233, 24275, 24277, 24864

OTHER

REFER ALSO TO CITATION(S) 24150, 24180, 24181, 24182, 24887

ENERGY CONVERSION

MHD GENERATORS

24937 (CONF-750601—P6) **Sixth international conference on magnetohydrodynamic electrical power generation, Washington, D.C., USA, 9th—13th June 1975. Volume VI. Proceedings.** Klepeis, J.E. (ed.). (Energy Research and Development Administration, Washington, D.C. (USA). Office of Fossil Energy). 1975. 477p. Dep. NTIS $12.50.

From 6. international conference on magnetohydrodynamic electrical power generation; Washington, District of Columbia, USA (9 Jun 1975).

Rapporteur reports are presented on various papers that were presented at the conference. The original papers were previously indexed individually for the data base. Round table discussions on the status of MHD technology and the application of MHD to power systems are included. Also, brief conference summaries are included. (WHK)

24938 (CONF-750669—) **Second U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation.** (Energy Research and Development Administration, Washington, D.C. (USA)). 1975. 327p. (In English and Russian). Dep. NTIS $10.00.

From 2. U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation; Washington, District of Columbia, United States of America (USA) (5 Jun 1975).

Separate abstracts were prepared for the 17 papers presented. (WHK)

24939 (NP—21451) **Bibliography of Soviet developments in magnetohydrodynamics. No. 2, January—June 1976.** Hibben, S.G.; Stevovich, V.A. (Informatics, Inc., Rockville, Md. (USA)). 13 Oct 1976. 28p. Defense Advance Research Project Agency/TAO, Arlington, VA.

This bibliography has been compiled by Informatics Inc. in response to an ARPA contractual requirement to monitor current Soviet developments in the field of magnetohydrodynamics. The period covered is the first half of 1976, and includes all known references to MHD topics in open-source Soviet bloc material published or cited in that period. 181 references.

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 25005

24940 (ANL/ENG—76-04) **Experimental two-phase liquid-metal magnetohydrodynamic generator program. Annual report.** Petrick, M.; Fabris, G.; Cole, R.; Hantman, R.; Pierson, E.; Cutting, J. (Argonne National Lab., Ill. (USA)). Nov 1976. Contract W-31-109-ENG-38. 102p. Dep. NTIS $5.50.

A new diverging-channel liquid-metal MHD generator with gas injection along the insulating walls was built and placed in operation in late 1974. This generator yielded nearly-constant liquid velocity along the channel for near-design conditions, as desired for best performance. Extensive measurements of the generator terminal and internal parameters were made over a range of gas and liquid flow rates, magnetic field strengths, and load resistance values. Data are given for generator efficiency and load voltages, and the variations along the channel of liquid and gas velocities, pressure, local load factor, void fraction, and slip ratio. Comparisons are made with theoretical predictions. Tests made to evaluate the effectiveness of the gas injection indicated that the generator performance improved slightly as the amount of gas injected was decreased, and that the injected gas was not forming the desired pure-gas wall layer. Following this, air-water tests indicated that this was to be expected, and a one-dimensional computer model indicated that performance should be better without the partial flow obstruction of the gas injection ports. The gas injection ports were removed, and substantial improvement was obtained in generator performance—by far the best to date. Data comparable to that for gas injection is presented for this case. The future directions of the program, including the role of gas injection, and the modifications to the NaK-nitrogen facility are described.

24941 (CONF-750669—, pp 259-264) **Generation of an effective MHD data base.** Nash-Webber, J.L. (Massachusetts Inst. of Tech., Cambridge). 1975.

From 2. U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation; Washington, District of Columbia, United States of America (USA) (5 Jun 1975).

In Second U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation.

This paper introduces two principal themes. The first theme is a discussion of the types of data that we should plan to take on each major new MHD experiment and the levels of accuracy needed for each type, in order to make our expensive experiments truly cost effective. This implies a greater degree of attention to comprehensive instrumentation than has generally been the case hitherto, with concomitant implications for the expenditure on instrumentation and comprehensive data acquisition, of a larger fraction of the total budget allocated for a particular experiment than has been usual so far. The second theme is the question of improved dissemination of the data within the MHD community, given the increased attention to comprehensive data acquisition. The creation of a truly useful MHD data base is discussed. Such a data base must serve to link a relatively large number of designers and theoreticians with a necessarily rather small number of complex, expensive large-scale experiments. Moreover, these experiments are frequently of a "one shot" nature and impractical to reproduce; so all the data must be taken on the first run. It is concluded that only computer-based data acquisition systems can effectively be used, and it is suggested that these should have, as one mandatory output, magnetic tapes containing the raw data generated in each major experiment. These tapes should be encoded in a standard format allowing for simple data retrieval by an interested party. They would be stored and indexed in a library to be set up by the Energy Research and Development Administration (ERDA), as required by current legislation. A preliminary set of requirements on these data tapes and their ancillary documentation is proposed.

24942 (CONF-750669—, pp 279-287) **Open-cycle MHD systems modeling studies.** Amend, W.E. (Argonne National Lab., IL). 1975.

From 2. U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation; Washington, District of Columbia, United States of America (USA) (5 Jun 1975).

In Second U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation.

A computer code is currently under development at Argonne National Laboratory (ANL) for simulating open-cycle MHD (OC MHD) powerplants. In view of the many plant configurations proposed by researchers, this computer program has been developed with maximum flexibility so that a multitude of configurations can be examined, including both direct- and indirect-fired air preheaters. The code allows the user to string together the components for the MHD system in any desired order and to examine the design consistency and performance level of the system. The computer code is programed in a top-down manner in that the primary emphasis during the initial stages of development has been on the highest level of code logic, which integrates the components with provisions for the various component options, insuring that the proper information is passed between corresponding subsystems and that the bookkeeping procedures are set up so that ultimately system costs can be computed. Sufficient physical information has been put into the various subsystems so that meaningful energy balances can be made, the configurations can be checked for consistency with the second law of thermodynamics, and system efficiencies can be calculated. The sophistication of the computer simulation can be increased by increasing the physical information in the various subsystem modules. The OC MHD computer simulation has been employed to perform parameter sweeps for various configurations and to examine the consequences of constraints placed on cycle parameters. The preliminary results for one attractive configuration are presented. In addition, the ANL engineering systems optimization code has been developed and employed to look at the minimum costs as computed by a detailed high-temperature air preheater simulation.

24943 (CONF-750669—, pp 289-292) **Considerations on building the first commercial-scale MHD power station.** Morozov, G.N.; Pashkov, S.A.; Pishchikov, S.I.; Shumyatskii, B.Ya. (Inst. for High Temperatures, Moscow). 1975. (In English and Russian).

From 2. U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation; Washington, District of Columbia, United States of America (USA) (5 Jun 1975).

In Second U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation.

The potential role of MHD power systems is examined from the viewpoint of development trends in the U.S.S.R. Baseload MHD powerplants operating on solid fuels are viewed as promising, as are those using natural gas or residual oil. The conclusion is drawn that MHD central powerplants are very promising because of the following considerations: (1) emissions from small industrial furnace heating units and small boilers are far greater than those from central powerplants per unit of generated energy, making the latter more attractive from an environmental protection viewpoint. At the same time central power systems consume less fuel. For these reasons, it is expected that central power systems will provide up to 32 to 35 percent of the energy needs of large cities. (2) Inasmuch as central powerplants are situated near cities, they are supplied with clean fuels (natural gas and residual oil), which are necessary for first-generation MHD power systems. (3) Siting the first central power system near research centers and construction facilities will simplify the construction problems related to new complex components whose designs may have to be modified in the course of the construction. There is also a discussion of MHD system design to take advantage of increases in efficiencies obtainable by scaling up the system. As an example, a 565-MWt MHD powerplant is analyzed, including the working-fluid parameters of the MHD-generator and the steam-turbine sections of the facility. The characteristics of the important plant components are discussed: the MHD channel, the superconducting magnet, the steam generator, etc. The interaction between the MHD and steam-turbine units is discussed, and the feasibility of autonomous operation of the steam turbine is considered. The report concludes with an economic/engineering comparison of steam turbine and MHD generator plus steam-turbine systems and shows the latter to be superior.

MATERIALS, COMPONENTS, AND AUXILIARIES

24944 (CONF-750669—, pp 7-14) **Materials testing and characterization: why, how, and where.** Bates, J.L. (Battelle Pacific Northwest Labs., Richland, WA). 1975.

From 2. U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation; Washington, District of Columbia, United States of America (USA) (5 Jun 1975).

In Second U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation.

Testing and characterization are essential tools in the development of materials that can meet the very severe environmental conditions anticipated in the combustor, channel, air preheater, etc., of MHD power generators. Significant benefits can be realized if testing and characterization methods are planned jointly so as to complement one another. Some of the whys, hows, and wheres relating to cooperative testing and characterization, emphasizing electrodes and insulators for open-cycle, coal-fired MHD generators are discussed.

24945 (CONF-750669—, pp 15-25) **Plasma-sprayed electrode for MHD channels.** Virnik, A.M.; Dushin, Yu.A.; Mel'nikov, E.V.; Roshchin, B.V.; Telegin, G.P. (Inst. for High Temperatures, Moscow). 1975. (In English and Russian).

From 2. U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation; Washington, District of Columbia, United States of America (USA) (5 Jun 1975).

In Second U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation.

Much attention has been devoted to hot-electrode materials such as zirconia. In terms of current leadouts, metals of the platinum

group have been used primarily up to now. The plasma spraying technique facilitated the development of electrodes with current leadouts composed of refractory alloys and has facilitated the fabrication of a broad range of composite materials. The paper describes methods for increasing the thermal stability of plasma-sprayed materials by regulating residual pressures. Laboratory tests at the U-02 and U-25 laboratory test beds have shown that electrodes fabricated in this manner performed quite well. The electrode was stable over a wide surface-temperature range. Also discussed are recent results of studies on electrode arcing. The test bed studies (in an open plasma flow) have shown that the nature of the discharge is a function of many variables but mainly plasma conductivity, electrode surface temperatures, and current density.

24946 (CONF-750669—, pp 33-71) **Refractory concretes: candidate materials for MHD system components exposed to thermal stress.** Romanov, A.I.; Vysotskii, D.A.; Kurtepova, O.I.; Smirnova, L.G.; Krasnikov, A.V.; Chubarov, Yu.I. (Inst. for High Temperatures, Moscow). 1975. (In English and Russian).

From 2. U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation; Washington, District of Columbia, United States of America (USA) (5 Jun 1975).

In Second U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation.

Research at the Institute for High Temperatures has shown that certain refractory concretes can be successfully used for lining the thermally stressed surfaces of MHD power system components, such as the MHD channel, the combustion chamber, the steam generator, and the gas ducts. These concretes are essentially particle-reinforced composite materials. The advantages concretes have over ceramics is their technological simplicity, the ease with which forms that are complex, large, or both can be fabricated, and a number of other desirable properties, such as high thermal stability, good thermal contact with the cooling system, ease of lining reinforcement, and attachment of various sensors. Commercial refractory concretes do not have the desired combination of necessary properties to meet the materials requirements imposed by the various elements of the MHD generator, such as good refractory properties, resistance to alkaline seed, and good electrical insulation. The Institute for High Temperatures has conducted a number of studies on the development and study of refractory concrete properties, based on refractory oxide fillers with hydrated and phosphate binders. The physical-chemical processes involved in phosphate hardening (the cements and concretes based on phosphates) were investigated. The studies and results are reported.

24947 (CONF-750669—, pp 73-84) **Electrode stabilization.** Bowen, H.K. (Massachusetts Inst. of Tech., Cambridge). 1975.

From 2. U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation; Washington, District of Columbia, United States of America (USA) (5 Jun 1975).

In Second U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation.

Design of MHD electrode modules for long-term, baseload electrical power generation requires the selection of operating conditions, additives, etc., to stabilize the electrode modules against chemical, electrical, thermal, and mechanical degradation. Examples are given of current U.S. concepts for electrode stabilization.

24948 (CONF-750669—, pp 293-308) **Special properties of a steam generator for an MHD power station.** Morozov, G.N.; Mostinskii, I.L.; Rabkin, Yu.I.; Tager, S.A. (Inst. for High Temperatures, Moscow). 1975. (In English and Russian).

From 2. U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation; Washington, District of Columbia, United States of America (USA) (5 Jun 1975).

In Second U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation.

The role of the steam generator in an MHD power system is examined, including its contribution to power generation and energy-flux distribution in the steam generator and adjoining hardware. The main functions of the steam cycle are to drive air compressors and oxygen generators, to preheat the fuel and oxidizer, to break down the NO/sub x/, and to recover some of the seed. Many of the peculiarities associated with steam-generator operation in an MHD power system are associated with its location in the overall cycle—downstream from the MHD generator—where it is exposed to high working-fluid temperatures at the inlet and to a highly radiating heating component, where the steam superheater is displaced into the radiant zone, where a diffuser is introduced to reduce working-fluid velocity and restore pressure, and other inclement conditions prevail. The behavior of alkaline seed in the steam-generator channel is examined, as is its effect on heating surfaces. The necessity for recycling the exhaust gases into the region leading to the convective surfaces for the purpose of temperature stabilization is shown. Also considered are aspects pertaining to the control of steam-generator loading, such as temperature increase at the steam-generator inlet when the MHD-generator power output is reduced and the installation of burners for autonomous operation when the MHD generator is shut down.

24949 (CONF-750669—, pp 317-325) **Some aspects of directly fired air heaters.** Decoursin, D.G.; Lindahl, B.C. (Fluidyne Engineering Corp., Minneapolis). 1975.

From 2. U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation; Washington, District of Columbia, United States of America (USA) (5 Jun 1975).

In Second U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation.

A directly fired air heater for a coal-fired MHD plant must be designed so that the flow passages will not become clogged with seed and slag. The tendency for seed and slag to accumulate in the heater will be strongly dependent upon the heater temperature cycle. Temperature cycles of parallel-flow and counterflow regenerative heaters are examined with respect to the potential clogging problem. The results indicate that a parallel-flow arrangement offers advantages in the handling of seed and slag, but the counterflow arrangement generates lower thermal stresses and can produce higher outlet air temperatures.

24950 (TID—27144) **MHD combustor design study. Final report.** (Rockwell International Corp., Canoga Park, Calif. (USA). Rocketdyne Div.). 28 May 1976. Contract W-31-109-ENG-38;SUB-31-109-38-3387. 440p. Dep. NTIS $11.75.

The development of coal-fired MHD systems is being pursued actively by ERDA because of its potential for significant increases in the overall efficiency of utility power generation stations, thereby maximizing the utilization of our fossil fuel resources. Over the past 10 years, ERDA and OCR have funded sufficient studies to clearly show that MHD is economically competitive with conventional steam generating plants, and demonstrated the engineering feasibility of MHD power generation. The next logical step is to develop and demonstrate MHD at the commercial demonstration scale. As part of the ERDA National MHD plan, the first step to this goal is the demonstration of an MHD system at the 25-MW/sub t/ size. This report contains the results of a 4-month ERDA-sponsored study to define a 25-MW/sub t/ coal-fired MHD combustor concept, and development program leading to the demonstration at the CDIF. This report describes the results of an analytical study and conceptual design study, including alternate concepts, conducted for a 25-MW/sub t/ coal-burning combustor that will supply hot gases to an MHD channel. The combustor assembly is to be delivered to the Component Development and Integration Facility (CDIF) sited for Butte, Montana. Also included in this report is a program plan for the design, fabrication, development, and testing of the 25-MW/sub t/ combustor and selected components; a test program to be conducted at the CDIF; a cost estimate and schedule for the design, fabrication, and development effort; and an analysis and description of a 2000-MW/sub t/ coal-burning combustor with the limitations to scaling up to such a combustor size.

24951 (TID—27145) **TRW 25 MW/sub T/ staged MHD coal combustor conceptual design study.** (TRW Defense and Space Systems Group, Redondo Beach, Calif. (USA)). 4 Jun 1976. Contract W-31-109-ENG-38;SUB-31-109-38-3386. 363p. Dep. NTIS $10.50.

A 25 MW/sub T/ coal-fired combustor design and development program for MHD application is described. Included in this report are a discussion of the conceptual design and operational characteristics, and a description of the interfaces with the planned Montana Component Development and Integration Facility (CDIF). A program plan for the development and testing of the combustor and the scaleability of the design to larger sizes is also presented. Overall, the 25 MW/sub T/ combustor is a right cylinder approximately 9 ft. long by 30 in. diameter, and weighs 2700 lbs. It is a two-stage device which mixes and burns 25 megawatts thermal input of coal with pre-heated air (up to 2900°F) and potassium carbonate seed to produce a uniform plasma at a nominal pressure of 8 atmospheres, an exit Mach number of 0.3 and a stagnation temperature up to 4950°F. The coal is carried into the combustor by dense phase transport, with the desired transport medium being low temperature air, at a solids-to-gas ratio of up to 50:1. The first stage operates at a fuel-rich condition. A vortex action is induced to remove most of the ash present in the coal in the form of liquid slag. This vortex action is provided by a combination of axial and tangential air injection. From an experimental standpoint, the combined axial/tangential air flow split can be proportional to provide differing internal particle ballistics and differing resulting slag carryover.Potassium carbonate seed material, and the balance of the air required for stoichiometric combustion, are introduced at the entrance to the second stage. The air is admitted into the second stage with a tangential velocity component which is designed to null the first stage vortex action. The combustor is principally constructed of a water-cooled, all metal nickel-base alloy. The overall heat losses to the cooling water are approximately 5% of the coal thermal input.

DUCT ENGINEERING AND FLUID DYNAMICS

REFER ALSO TO CITATION(S) 23948, 24940, 25221

24952 (CONF-750669—, pp 93-110) **Considerations in the design and analysis of open-cycle MHD generators.** Doss, E.D.; Cutting, J.C.; Maxwell, C.D.; Patel, N.J.; Demetriades, S.T. (STD Research Corp., Arcadia, CA). 1975.

From 2. U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation; Washington, District of Columbia, United States of America (USA) (5 Jun 1975).

In Second U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation.

The two-dimensional, coupled code developed by STD Research Corp. is a powerful analytic tool in the design of the open- and closed-cycle MHD generators. It has been previously presented at various MHD meetings. The purpose of this paper is to review briefly the primary models contained in this computer code and to indicate the results of calculations performed on various MHD channels in support of the joint U.S.-U.S.S.R. program. Details of the electric and gas-dynamic solutions and the method of coupling them together are presented. In addition, the techniques used to model the surface roughness are discussed. A summary of results obtained in the analysis of several MHD channels is presented. The effects of wall temperature and flow rate upon the performance of the U-25 generator are discussed as well as a preliminary design of a channel to be tested in a superconducting magnet in a side loop of the U-25 facility. Also presented are performance calculations for the U-25 channel designed in the United States for testing in the U.S.S.R. Performance criteria at the channel design point and selected off-design points are discussed together with various tradeoff parameters that influence channel performance. The conditions for boundary-layer separation as a function of load current are discussed.

24953 (CONF-750669—, pp 111-150) **U-25 diagonal MHD generator channel studies.** Barshak, A.E.; Bityurin, V.A.; Kovbasyuk, V.I.; Maksimenko, V.I.; Medin, S.A.; Momotov, Yu.M.; Pashkov, S.A.; Pinkhasik, D.S. (Inst. for High Temperatures, Moscow). 1975. (In English and Russian).

From 2. U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation; Washington, District of Columbia, United States of America (USA) (5 Jun 1975).

In Second U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation.

The report discusses the construction and testing of the R channel in the U-25 facility. The R channel is an experimental diagonal wall channel designed for the U-25. The channel design is more conservative than the earlier U-25 number 1 Faraday channel. The major design parameters are: mass flow, 30 kg/sec; maximum Hall voltage, 2 kV; electric power, 3 MW. The report describes the channel's design specifications, the experience gained in operating the channel, and the behavior of high-temperature materials used in its construction. The results of measurements made in the channel are discussed. They were used to determine the distribution of the basic gas-dynamic and electrical parameters in the channel. Also discussed is the comparison of the experimental findings with the theoretical predictions. Data analysis showed that the distribution of the gas-dynamic parameters along the channel is a function of the level of interaction of the current with the magnetic field. The method used for determining the median working-fluid conductivity on the basis of the extracted experimental data is described. Considerably greater difficulties were encountered in analyzing the data obtained from the diagonal channel runs than were incurred with the Faraday channel.

24954 (CONF-750669—, pp 157-178) **Interelectrode breakdown in the U-02 MHD generator channel.** Burenkov, D.K.; Dolinskii, Yu.L.; Zalkind, V.I.; Zelikson, Yu.M.; Kirillov, V.V.; Sokolov, Yu.N.; Uspenskaya, G.I. (Inst. for High Temperatures, Moscow). 1975. (In English and Russian).

From 2. U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation; Washington, District of Columbia, United States of America (USA) (5 Jun 1975).

In Second U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation.

Electrical breakdown between adjacent electrodes in a Faraday channel in the direction of the Hall effect is a critical phenomenon in large-scale MHD generators and influences the performance, life, and cost of the generator. The present paper presents the experimental results of the studies on this phenomenon in the U-02 facility and compares them with theoretical expectations derived from computations based on an interelectrode breakdown developed by MIT. The experiments were conducted using experimental MHD channels with two types of interelectrode gaps. One contained a 28-mm-thick hot ceramic and the other contained a cold dense ceramic confined in copper frames with embedded ceramic electrodes. All of the experimental runs showed a smooth increase in the Hall voltage reading in the interelectrode gaps with increases in the transverse current. However, when the Hall voltage across the gap reached 60 V, further voltage increases were very much slower, and at the 70- to 80-V level "saturation" was observed. It is very curious that a comparatively large potential (up to 80 V) was observed between adjacent electrodes at transverse current densities of up to 1 A/cm^2. It is even more curious in view of the fact that the maximum tolerated Hall voltage between adjacent electrodes in the Mark VI and Mark VII channels was about 40 to 50 V. Comparison of Hall current leakage in the two types of gaps showed that the maximum or limit Hall voltage was higher in the hot ceramic gap (80 to 85 V) than in the cold gap (60 V). It should also be noted that current-distribution analyses showed considerable current leakage (with high transverse currents) into the copper cooling frames, which apparently constricts arc formation.

24955 (CONF-750669—, pp 179-189) **Theoretical observations on electrical breakdown and arc formation in MHD generators.** Oliver, D.A. (Massachusetts Inst. of Tech., Cambridge). 1975.

From 2. U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation; Washington, District of Columbia, United States of America (USA) (5 Jun 1975).

In Second U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation.

Conditions under which the discharge in a combustion-driven MHD generator may become constricted rather than diffuse are presented. Two classes of constricted or arc-like discharges are considered: 1. That of interelectrode thermal arc formation because of the excess Joule heating on insulator surfaces. 2. That of constriction of the transverse current to the electrode because of its passage through a cool boundary layer. Both classes of arc formation are shown to depend strongly upon the generator interaction parameter, the heat conduction rate in the boundary layer, and the Hall parameter. Methods of alleviating both forms of arc formation are discussed.

24956 (CONF-750669—, pp 193-205) **Boundary-layer measurements of velocity temperature, and electron-density profiles in combustion MHD generator channels.** Self, S.A.; Kruger, C.H.; Daily, J.W.; Koester, J.K.; Clements, R.M. (Stanford Univ., CA). 1975.

From 2. U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation; Washington, District of Columbia, United States of America (USA) (5 Jun 1975).

In Second U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation.

The application of laser anemometry for determining the profiles of average velocity and turbulence intensity of MHD generator channels is discussed. The various basic types of laser anemometer systems are reviewed and assessed for their applicability to the hostile environment of MHD channel flows. An account is given of the experience at Stanford in developing a particular type of laser anemometer using a coaxial backscatter geometry, with the Doppler frequency shift determined interferometrically by the use of a scanning Fabry-Perot device. The problems encountered and methods adopted to overcome them are described. As presently developed, the instrument has a demonstrated capability of measuring the average velocity, to 1,600 m/sec with an accurcy of 2 percent, and turbulence intensity, with a spatial resolution of 0.1 mm to within 0.5 mm of the channel surface in an operating MHD generator. Recent measurements on Stanford's M-8 generator have yielded boundary-layer profile data, unobtainable by other means, which is of considerable significance for the understanding of MHD generator flows. Temperature and electron-density measurements have been made by spectroscopic means. Spatial and spectral resolution are obtained with a rotating-mirror optical system and a scanning monochromator. The temperature profiles have been measured by the use of an extension of the wing-reversal method. The results are compared with those based on profiles of emission intensity. Electron density is measured from the absolute and relative intensities of nonresonant potassium lines originating from high lying electronic levels (6D and 7D), which are in collisional equilibrium with the free electrons.

24957 (CONF-750669—, pp 207-229) **Generalized reversal methods in nonuniform, nonstationary plasma flow in an MHD generator.** Vasil'eva, I.A. (Inst. for High Temperatures, Moscow). 1975. (In English and Russian).

From 2. U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation; Washington, District of Columbia, United States of America (USA) (5 Jun 1975).

In Second U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation.

The plasma in an MHD generator is typically nonuniform over the volume of the channel and is nonstationary. The latter fact must be taken into consideration when determining temperatures by the use of the generalized transformation method. The generalized method assumes that the Kirchhoff law is satisfied. When the radiator has a nonuniform temperature distribution the Kirchhoff law is applicable to its individual regions, but not to the radiator as a whole. Such temperature calculations characterize the mean volume. The outcome of the averaging depends upon the degree of the radiator's nonuniformity. This paper examines the discrepancy between the measurable temperature and the temperature at the nucleus of the flow with typical correlations between the spectral line

widths, instrumental function, and the instrument's exit slit. Expressions are derived for determining the temperature at the nucleus of the flow using measured temperatures. In deriving the basic formula in the generalized transformation method, the assumption is made that the radiation intensities of the plasma, the reference source, and the combined intensity of the plasma together with the reference source are measured simultaneously in a time frame much smaller than the time of plasma temperature variation. Furthermore, it is assumed that the time constant of the temperature recorder is negligibly small. In those cases where these assumptions are not met, a methodological error is introduced into the measurements. In practice, the generalized transformation method has two versions. In the first, all three intensities are recorded simultaneously using a two- or three-probe method. In the second, the intensity is recorded using a single probe in a sequential manner.

24958 (CONF-750669—, pp 231-249) **Investigation of the far wings of resonance lines of alkaline metals in combustion-products plasma.** Vasil'eva, I.A.; Deputatova, L.V.; Nefedov, A.P. (Inst. for High Temperatures, Moscow). 1975. (In English and Russian).

From 2. U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation; Washington, District of Columbia, United States of America (USA) (5 Jun 1975).

In Second U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation.

It is convenient to study the equilibrium low-temperature plasma generated by combustion products on the basis of the resonance lines of the alkaline metal, whose salts are frequently injected into the combustion chamber. Under the operating conditions of large-scale open-cycle MHD generators the width of these resonance lines can be several tens to several hundreds of angstroms. To determine the plasma parameters from the line contours, it is necessary to know the coefficient of absorption as a function of wavelength at large distances from the center of the line. The paper attempts to experimentally derive the coefficient of absorption as a function of wavelength k(lambda) in the wings of the resonance doublets for sodium (5,890 and 5.896 A) and potassium (7,665 and 7,599 A). Experiments to determine the k(lambda) function used the combustion products of natural gas in air, obtained with a specially fabricated burner with a centrally located torch, with a constant cross-section temperature, and with a constant seed density. Tests were also run on the U-02 when plasmas of high optical densities were encountered. The coefficient of absorption was measured at distances of 2 to 100 A for sodium and 10 to 550 A for potassium. The coefficient of absorption was obtained for the wings of each individual doublet line, as well as that for the sum total of all of the doublet wings. Results are reported.

24959 (CONF-750669—, pp 269-273) **Presentation by D. B. Stickler.** Stickler, D.B. (Avco-Everett Research Lab., Everett, MA). 1975.

From 2. U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation; Washington, District of Columbia, United States of America (USA) (5 Jun 1975).

In Second U.S.-U.S.S.R. colloquium on magnetohydrodynamic electrical power generation.

Results of some experimental tests of the development of a coal-slag coating on various channel-wall configurations under subsonic flow conditions in a small test channel designed only to study such phenomena are reported. The run conditions thus far worked with involve a flow rate of about 1 kg/sec a stagnation pressure of about 2.2 atmospheres, a stagnation temperature of about 2,800 K, a Mach number in the test section of 0.6, and a Reynolds number of about 2 x 10^6. These tests are with clean-fuel combustor, the Mark VI combustor, into which some coal feed is introduced to provide the slag from which the coating develops. (WHK)

24960 (AD-A—017803) **New developments in the area of magnetohydrodynamic current generators.** Fritzer, P.K. Translated from *Elektrotech. Maschinenbau;* **91**: vp.(Mar 1974). 20p. (FTD-HC—23-1105-75). NTIS.

Topics include couplings and multi-dimensional effects in the MHD channel, Hall effect and cross velocity, meaning of the boundary conditions: viscosity for stabilizing a channel flow, heat transfer, and theoretical consequences.

24961 **Thermodynamics of liquid-metal MHD generators.** Baehr, H.D. (Institut fuer Mechanik und Thermodynamik der Hochschule der Bandeswehr, Hamburg). *Brennst.-Waerm:e-Kraft;* **28**: No. 9, 351-356(Sep 1976). (In German).

Magnetohydrodynamic generators with liquid metals offer the advantages of high output density and lower working temperatures due to the great electric conductivity of these fluids. On the other hand, it is difficult to accelerate a liquid in a cycle process by adding thermal energy. Based on general thermodynamic considerations, minimum values are deducted for the degrees of reversibility of the cycle processes for liquid-metal MHD systems which may serve as topping stages for conventional power stations. It shows that there are no prospects for applying liquid-metal MHD generators for this purpose. This is also proved by the efficiency calculations for the unary condensation process, if a realistic assessment of the quality grades of the various plant components is carried out.

THERMIONIC CONVERTERS

DESIGN AND DEVELOPMENT

24962 **Thermionic converter.** Bohdansky, J.; van Andel, E. (to Commission of the European Communities). German(FRG) Patent 1,539,288/B/. 22 Jan 1976. 3p. (In German).

2 figs. Available from Dt. Patentamt, Muenchen (FRG).

In thermionic converters for direct conversion of thermal into electric energy consisting of a heated emitter electrode and a collector electrode cooled by a heat pipe, the temperature of the heat pipe can be raised by influencing its cooling properties in such a way that the vapor pressure of the cesium filling the space between the electrodes is always adjusted in optimum relation to the actual emitter temperature and an optimum converter function is achieved at all operational temperatures. According to the invention, this results from the use of thermal shields which can be showed by means of bimetallic strips or from introduction of a gas plug in the part of the heat pipe remote with respect to the electrodes.

PERFORMANCE AND TESTING

24963 **Direct measurement of cesium adsorption on high-temperature surfaces using radioactive tracers.** Collier, R.K.; Backus, C.E. (Arizona State Univ., Tempe). *Nucl. Technol.;* **31**: No. 2, 279-281(Nov 1976).

A radioactive tracer technique was used for directly measuring adsorbed material on surfaces typical in thermionic energy converters. Previously used techniques did not allow measurements to be made under the conditions expected in an operating diode. In these experiments, cesium tagged with radioactive ^{134}Cs was adsorbed onto tantalum surfaces. Cesium arrival rates from 10^{16} to 10^{21} atom/(cm^2 sec) and tantalum surface temperatures from 500 to 1700°K were investigated. The experimental curves were smooth and reproducible, establishing a high level of confidence in the technique.

FUEL CELLS

DESIGN AND DEVELOPMENT

24964 (EPRI-EM—335) **Advanced technology fuel cell program. Final report.** King, J.M. Jr. (United Technologies Corp., South Windsor, Conn. (USA). Power Systems Div.). Oct 1976. 107p. Dep. NTIS $5.50.

Efforts under RP114 in 1971 and 1972 showed that high efficiency in low ratings, modular design, and low pollution characteristics permit siting fuel cell generators at dispersed locations in the electric utility transmission and distribution network, with substantial benefit to the electric utility industry. Two efforts evolved from the initial RP114 activity. The first is to develop and demonstrate FCG-1 - the initial dispersed generator. The second, under the continuation of RP114, is focused on establishing the technical feasibility of advanced concepts to improve the economic characteristics, fuel flexibility, and operating flexibility of dispersed generators and on estimating the potential characteristics of central station fuel cell powerplants operating on coal. This report describes the results of the RP114 activity at the Power Systems Division of United Technologies and several subcontractors between April 1973 and March 1976. Activities directed at improved economics focused on the fuel cell power section and demonstrated that molten-carbonate fuel cell powerplants could meet the program heat rate goal of 7500 Btu/kWh at a cost less than or equal to initial dispersed generators. Efforts to broaden fuel capability focused on broader liquid fuel capability for dispersed generators and on coal central station concepts. Hydrodesulfurization of naphtha was adapted to fuel cell conditions; catalyst endurance and the ability to use naphthas from a range of U.S. refineries were demonstrated. A 520-hour test demonstrated the technical feasibility of operating on No. 2 fuel oil. A study of centralstation coal powerplants showed integrated powerplants consisting of a gasifier, fuel cell, and bottoming cycle provide estimated overall efficiencies of 40 percent for plants based on the phosphoric-acid cell and of 50 percent or higher for powerplants based on the molten-carbonate cell. (WHK)

24965 (EPRI-EM—336) **Economic assessment of the utilization of fuel cells in electric utility systems. Final report.** Wood, W.; Bhavaraju, M.P.; Yatcko, P. (Public Service Electric and Gas Co., Newark, N.J. (USA)). Nov 1976. 113p. Dep. NTIS $5.50.

The objective of this study is to evaluate the long-range economic benefits of first generation and advanced fuel cells in the

future generation capacity plans of a representative electric utility system. The benefits of fuel cells' unique characteristics such as lower heat rate, relatively flat heat rate characteristic, better availability, reduced construction lead time, and dispersed siting are separately quantified utilizing reliability, production cost, and optimum generation mix methods commonly used in generation planning in utilities. Based on the results of this study, the first generation fuel cells appear to be attractive for intermediate duty in a utility expansion program if the EPRI projected goals of $250/kW installed capital cost, including fuel storage and electrical connections, and 9300 Btu/kWh heat rate can be met. The penetration of this generation will depend on factors specific to an individual utility such as fuel availability and cost, environmental constraints, load factor and the other generation options coupled with the relevancy of special fuel cell penalties and savings—such as stand-by or start-up costs (if used daily) or T and D deferrals (if dispersed). The second generation fuel cells will have significant market penetration at installed capital costs of $200-300/kW and a 7500 Btu/kWh heat rate. This penetration will likely be constrained by fuel price and availability. This report discusses in some depth the relationships between market penetration, fuel price, and capital cost for the two fuel cell types. In addition it quantifies the various penalties and savings that might occur to a utility through the installation of fuel cells.

24966 **Hydrogen energetics and fuel cells.** Gurevich, I.G.; Skundin, A.M. (Inst. of Heat and Mass Exchange, Minsk). *Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk;* No. 3, 46-54(1976). (In Russian).

A short historical survey of the problem of fuel cells (firstly, hydrogen-oxygen fuel cells) is made, and the perspectives of their development are discussed.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 24146

24967 (EPRI-EM—271) **ac/dc power conditioning and control equipment for advanced conversion and storage technology. Final report.** Wood, P. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). Nov 1976. 109p. Electric Power Research Inst., Palo Alto, CA.

This report presents the results of the work performed since the publication of the key phase report for this project in August, 1975. This final report concludes that the two most likely long-range candidates for converting dc to ac power from batteries and fuel cells are the basic current-fed line commutated inverter (a derivative of HVDC technology), and the voltage-fed conduction angle controlled force commutated inverter. Results are presented for analyses of cost, performance, and reliability which lead to the identification of the current-fed line commutated technology as the most promising long-range choice. This conclusion is drawn for characteristics of today's solid state devices, as well as for forecast improvements in the future in those characteristics. Other conversion technologies are discussed and removed from further consideration because of their inability to satisfy cost, performance, or reliability goals. In addition, information about technology projections, control philosophy, and commutating circuits is included in this report.

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 24905

BUILDINGS

REFER ALSO TO CITATION(S) 24866, 24905, 24908, 24909, 24910

24968 (COO—2791-2) **Energy use for building construction. Progress report, March 1, 1976—August 1, 1976.** Hannon, B.M.; Stein, R.G.; Segal, B.; Serber, D.; Stein, C. (Illinois Univ., Urbana (USA). Center for Advanced Computation). Aug 1976. Contract E(11-1)-2791. 83p. Dep. NTIS $5.00.

Total (direct and indirect) energy requirements of the construction industry for 1967 were determined in order to examine the potential for energy savings. The Energy Input/Output Model developed at the Center for Advanced Computation, University of Illinois, was expanded to include a detailed breakdown of the industry and energy intensities of 49 building construction (new and maintenance) sectors and of the overall building construction industry were determined for 1967. The latter figure was computed at about 70,000 Btu/$, i.e., the construction industry on the average required about 70,000 Btu of direct and indirect energy per dollar of output produced. In addition, total energy requirements to final demand were developed for the construction industry for 1967. The overall industry required about 6000 trillion Btu, or about nine percent of the total U.S. energy requirement. Energy requirements were further broken down according to goods and services purchased by individual construction sectors, and energy distribution patterns were determined. Energy cost per unit for several input materials to construction were calculated, as well as energy cost per square foot for various building sectors in 1967. Laboratories and hospitals required the most energy per square foot (2,073,755 Btu/ft^2 and 1,722,172 Btu/ft^2, respectively), while warehouses required the least (558,403 Btu/ft^2). Finally, a prototypical study was conducted to determine industries in which direct energy use led to a significant amount of energy embodied in new construction for 1967. The resulting energy flow chart is included.

24969 (ERDA-tr—245) **Thermal insulation in multistory buildings.** Sep 1974. Translated from German Standards. 18p. Dep. NTIS $3.50.

The energy savings possible during the heating season only with increased thermal insulation in multistory buildings are calculated and explained and guidelines for obtaining the optimum economical insulation are presented. (LCL)

24970 **Method and equipment to defrost an evaporator in a heat pump.** Gustafsson, B.U. (to Projectus Industrieprodukter AB). German(FRG) Patent 2,520,319/A/. 20 Nov 1975. 13p. (In German).

2 figs. Available from Dt. Patentamt, Muenchen (FRG).

Characteristic for this method to defrost the evaporator of an air heat pump is the fact that the pressure difference of the air over the heat exchanger is recorded and that a signal to revert the flow direction is given when a certain value for the pressure difference has been reached. Moreover, the temperature near the last defrostable part of the heat exchanger is recorded so that the flow direction is renormalized when this temperature exceeds O°C.

24971 **Heat sources - the suitability of different heat sources for heat pump operation - attempt of a systematic representation. Pt. 1.** Paul, J. (Essen Univ. (Gesamthochschule) (Germany, F.R.). Abt. fuer Thermodynamik). *Kaelte (Hamburg);* **29**: No. 1, 4-8(1976). (In German).

3 figs. Part of a thesis by the author.

There are a number of possibilitis for operating heat pumps with high degrees of efficiency using sources of waste heat, heated rivers in industrial regions and air conditioners for example. 'Natural' heat sources, such as soil, ground water, or solar energy, are in general very usable, although combination with other heat sources may make them more so. In the future, attention should be paid to the utilization of solar energy which is not only available as radiation energy but also as stored energy in water and soil. Similar to the ambient air, solar energy is available everywhere during the whole year, only with different thermal qualities. Utilization of the heat of the ambient air is very common today, although the ambient air shows characteristics comparable with solar energy. This is why the utilization of solar energy should be advanced. The characteristics and forms of the heat source water are discussed after some introductory remarks concerning heat pumps.

24972 **Heat sources - the suitability of different heat sources for heat pump operation - attempt of a systematic representation. Pt. 2.** Paul, J. (Essen Univ. (Gesamthochschule) (Germany, F.R.). Abt. fuer Thermodynamik). *Kaelte (Hamburg);* **29**: No. 2, 44-53(1976). (In German).

With figs. Part of a thesis by the author.

There are a number of possibilities for operating heat pumps with high degrees of efficiency using sources of waste heat, heated rivers in industrial regions and air conditioners. 'Natural' heat sources, such as soil, ground water, or solar energy, are in general very usable, although combination with other heat sources may make them more so. In the future, attention should be paid to the utilization of solar energy which is not only available as radiation energy but also as stored energy in water and soil. Similar to the ambient air, solar energy is available everywhere during the whole year, only with different thermal qualities. Utilization of the heat of the ambient air is very common today, although the ambient air shows characteristics comparable with solar energy. This is why the utilization of solar energy should be advanced. Several forms of water are considered as heat sources for heat pumps. Special characteristics of air are also discussed.

24973 **Heat sources - the suitability of different heat sources for heat pump operation - attempt of a systematic representation. III.** Paul, J. (Essen Univ. (Gesamthochschule) (Germany, F.R.). Abt. fuer Thermodynamik). *Kaelte (Hamburg);* **29**: No. 3, 82-92(1976). (In German).

4 tabs.; 26 refs.; with figs. Part of a thesis by the author.

There are a number of possibilities of operating heat pumps with high degrees of efficiency can - to speak globally - be found at

points where there is waste heat, heated rivers in the industrial regions and air conditioners for example. 'Natural' heat sources, such as soil, ground water, or solar energy, are in general very usable, although combination with other heat sources may make them more so. In the future, attention should be paid to the utilization of solar energy which is not only available as radiation energy but also as stored energy in water and soil. Similar to the ambient air, solar energy is available everywhere during the whole year, only with different thermal qualities. Utilization of the heat of the ambient air is very common today, although the ambient air shows characteristics comparable with solar energy. This is why the utilization of solar energy should be advanced. The use of illumination heat, and soil as a heat source for heat pumps are examined. The possibilities to combine various sorts of heat sources including solar energy are explained.

24974 Arrangement to heat a flowing medium, preferably water, in a conventional central heating system by means of the waste heat generated by a number of refrigerating apparatus. Gustafsson, B.U. (to Projectus Industrieprodukter AB). German(FRG) Patent 2,606,053/A/. 26 Aug 1976. 15p. (In German).

2 figs. Available from Dt. Patentamt, Muenchen (FRG).

A description is given of an arrangement to heat a flowing medium, preferably water, in a conventional central heating system using the waste heat from a number of refrigerators each of which has its own coolant cycle. A heat pump is provided which takes up thermal energy from the condensers of the refrigerators via its evaporator unit and then heats up the flowing medium by means of heat exchange in its condenser. This arrangement enables the best possible utilization of the heat released by the refrigerators without affecting their cooling power, and the intermittent and independent operation of the refrigerators does not interfere with the functioning of the heat pump.

24975 Heat pump. Daniel, W. (to Bosch (R.) G.m.b.H.). German(FRG) Patent 2,507,211/A/. 2 Sep 1976. 9p. (In German).

1 fig. Addition to: P24515444. Available from Dt. Patentamt, Muenchen (FRG).

A description is given of a heat pump with a preparation installation for service water, characterized by a multi-port valve which is connected to the outlet of this plant and which has a circuit leading back to the heat pump and one leading to an additional heating installation. The multi-port valve is a three-way valve, electro-magnetically controlled and controlled dependent on the temperature in the service water installation. The purpose of the invention is to enlarge the overall efficiency of the plant through the insertion of an additional heating installation.

24976 Heat pump. Mendler, W.; Haeberle, K.; Kroell, U.; Kragl, W. (to Bosch (R.) G.m.b.H.). German(FRG) Patent 2,509,319/A/. 16 Sep 1976. 9p. (In German).

4 figs. Available from Dt. Patentamt, Muenchen (FRG).

A heat pump is described in which the compressor is powered by an infinitely variable electric multipe motor. Between the electric motor and compressor, a gear box or variable gear box is arranged, all of which is placed in a casing. The gear box is hydraulically or mechanically infinitely variable. The heat pump adapts better to the heat requirements than is possible with off-on gear boxes or automatic waste controls (pressure suction controls).

24977 Method of creating an outdoor ice slab in summer weather and of reducing energy requirements for indoor and outdoor ice rinks. MacCracken, C.D. US Patent 3,983,713. 5 Oct 1976. Filed date 5 May 1975. 10p.

Previously it has been impractical to create and hold ice for the purposes of ice skating, curling or sliding during summer weather unless the area was completely enclosed. A method for doing this which is practical not only by keeping refrigeration requirements low but also by eliminating dripping, fogging and surface melting is described. This method also has the advantage of reducing energy requirements for holding an ice slab under indoor or outdoor conditions. The method includes creating a floor for ice under which tubes or pipes containing an antifreeze solution are laid, connecting a refrigeration plant to chill and recirculate the antifreeze solution, suspending a surface of aluminum foil facing downward covering the entire ice floor at least 10 feet above such floor, mounting fans to recirculate the air from below such aluminum surface to above it, freezing ice by applying water upon the floor, painting the ice white to reflect radiant energy, freezing more ice above the white paint, erecting a solid perimeter fence around the ice floor, blowing air through a header box alongside the rink to dehumidify the air and delivering that air through openings in the perimeter fence onto the ice floor area and certain combinations of the above steps. The low emissivity of the aluminum foil and the high reflectivity of the white paint prevent radiant energy from loading the ice while recirculation fans warm the cool moisture-laden and often foggy air over the ice by conveying it to the warm area above the suspended ceiling.

RESIDENTIAL

REFER ALSO TO CITATION(S) 24201, 24933

24978 (BNL—50576) Energy management in residential and small commercial buildings. Annual report, fiscal year 1976. Batey, J.; Gazerro, V.; Salzano, F.J.; Berlad, A.L. (Brookhaven National Lab., Upton, N.Y. (USA)). Jul 1976. Contract EY-76-C-02-0016. 54p. Dep. NTIS $4.50.

The goal of the present program is to develop the technical basis for efficient energy use in space heating of residential and small commercial buildings. Efficiency measurements performed on conventional residential oil-fired hot water heating equipment, including both steady state and cyclic (part load) efficiency determinations are described. A list of preliminary recommendations for retrofit actions to improve efficiency is provided. A summary of work carried out in the areas of thermal storage media, fenestration, and building thermal dynamics is also presented.

COMMERCIAL

REFER ALSO TO CITATION(S) 24978

TRANSPORTATION AND PROPULSION

REFER ALSO TO CITATION(S) 24905

24979 (UCID—17316(Pt.2)) Transportation-related data bases extracted from the national index of energy and environmental data bases. Part II. Detailed data base descriptions. Birss, E.W.; Yeh, J.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Nov 1976. Contract W-7405-ENG-48. 277p. Dep. NTIS $9.25.

Lawrence Livermore Laboratory (LLL) extracted a set of 135 transportation-related data bases from a computerized national index of energy and environmental data bases. LLL had produced the national index for the Division of Biomedical and Environmental Research of the Energy Research and Development Administration (ERDA). The detailed transportation-related data base descriptions presented are part of a LLL ongoing research contract with the Information Division of the Transportation Systems Center of the U. S. Department of Transportation (DOT/TSC).

INDUSTRY

REFER ALSO TO CITATION(S) 24866, 24870, 24906, 24968

EQUIPMENT AND PROCESSES

24980 Aspects of reducing the energy consumption in olefin processing. Sohns, D.; Fuge, C. *Linde-Ber. Tech. Wiss.;* No. 39, 11-18(1976). (In German).

9 figs.; 3 tabs.; 1 ref.

Taking an olefin plant as an example, possibilities and limits of energy utilization of a process are shown. Proceeding from the exergy flow the determination of the exergy losses for all partial steps of a process takes place. This determination points out in which phase of the process improvements can be carried out to save energy. For olefin production, examples are given for improved utilization of waste heat flows (flue gases, quenching oil heat) for power saving during compression, and for energy saving by process modification.

WASTE HEAT UTILIZATION

24981 Wheel of good fortune. *Ind. Gas (Duluth);* **55**: 18-19(Mar 1975).

An energy recovery wheel manufactured by the Wing Co., Division of Aero-Flow Dynamic, Inc., is recovering 90% of the wasted sensible heat in exhaust air and using it to preheat incoming air for the paint shop of the Pennwalt S. S. White Dental Products Division in Holmdel N. J. The paint shop has a complete air change at two-minute intervals, maintaining minimum air movement at the paint-spray station at 120 ft/min/sq ft at a 75°F temperature level during the winter. The energy recovery wheel gives an annual saving of $13,000 in propane heating costs.

24982 Performance evaluation of an evaporative pad greenhouse system for utilization of power plant reject heat. Olszewski, M.; Trezek, G.J. (Univ. of California, Berkeley). *J. Environ. Qual.;* **5**: No. 3, 259-269(1976).

The overall performance of an evaporative pad greenhouse is considered in terms of the pad heat and mass transfer, the energy budget of the vegetation, and the performance of the power plant. An analytical predictive model for the pad performance was developed utilizing the Merkel total heat approximation. Data obtained from actual greenhouse performance provides an experimental verification of the pad model. Energy balance considerations on the vegetation provide a means of viewing optimal plant growth in

terms of the power plant energy dissipation. In general, the results indicate that when an evaporative pad greenhouse system is used for waste heat dispersal, the vegetation can be maintained within its thermal requirement zone, crop irrigation requirements are significantly reduced, and the power plant performance is comparable with conventional closed loop heat rejection systems.

24983 Method for simultaneous combined production of electrical energy and crude iron. Collin, P.H.; Johansson, F.K.E. (to Stora Kopparbergs Bergslags Aktiebolag). US Patent 3,985,544. 12 Oct 1976. Priority date 1 Nov 1971, Sweden. 12p.

The invention relates to a method of combined production of electrical energy and crude iron, comprising reducing iron oxides while keeping the temperature below the melting point of the crude iron during a pre- reduction and above said melting point during a final reduction. The pre-reduction is made by introducing carbonaceous material and the material containing iron oxides into a fluid bed containing solid carbonaceous material, producing reducing gases in the fluid bed by partial combustion of the carbonaceous material with air/or oxygen gas, pre-reducing the iron oxides by said reducing gases until the material has achieved a metallization degree of 30 to 80 percent, most of the heat requirement of the pre-reduction being covered by said combustion. The pre-reduced material is finally reduced and molten by being brought into contact with carbon, and the heat requirement of this final reduction and melting process is covered by electric heating. A substantial part of the exhaust gases from the reduction operations is passed to a thermal power station to generate electrical power therein.

24984 Method and apparatus for recovering low-temperature industrial and solar waste heat energy previously dissipated to ambient. Erb, G.H. US Patent 3,986,354. 19 Oct 1976. Filed date 15 Sep 1975. 20p.

A method and apparatus are described for recovering useful amounts of low-temperature industrial and solar waste heat energy previously dissipated to ambient. The low-temperature heat energy is used cyclically for heating and expanding a thermally expandable wall shown as a cylindrical walled structure located between two pumping chambers for simultaneously changing the volumes of the chambers in opposite senses. Then a cold sink is used cyclically for cooling and contracting the cylindrical walled structure for again simultaneously changing the volumes of both chambers in the opposite senses, i.e., in push-pull relationships. The cyclic change in volumes of the chambers displaces an incompressible fluid which is used for pumping a liquid from a reservoir for performing useful work, and, in one form of the invention, the liquid is directed into an accumulator under pressure, and the pressurized liquid in the accumulator may be utilized to perform useful work. A heat transfer fluid medium is used in one portion of the cycle to transfer heat energy from the energy source to heat and expand the cylindrical walled structure, and in another portion of the cycle to absorb heat energy from this walled structure to cool and contract it.

RECYCLING

REFER ALSO TO CITATION(S) 24886, 24894

ELECTRIC POWER

REFER ALSO TO CITATION(S) 24313

24985 Utilization of energy. Generating of electricity: wasting less. *Mosaic;* 5: No. 2, 33-35(Spr 1974).

A brief review is presented of various methods of producing electric power, e.g., hydroelectric power plants, thermal power plants, MHD, etc. Methods for conserving energy are also stressed. There are two kinds of energy conservation, i.e., by consuming less energy by combinations of social and political actions (lowering thermostats, carpooling, etc.) and conservation by technological innovations - the reduction of waste in the "handling" of energy. (RCK)

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 24886, 24887, 24911

24986 Process to desulfurize gas and recover sulfur. Guerrieri, S.A. (to Univ. of Delaware). US Patent 3,987,147. 19 Oct 1976. Filed date 21 Feb 1974. 8p.

A continuous cyclic process for removing sulfur dioxide from gases produced in the combustion of fossil fuels or in chemical and metallurgical operations by means of an aqueous solution including the carbonate of an alkali metal to absorb said oxide out of said gases whereby the metal carbonate is converted into the metal sulfite. A two step recovery process is employed to reproduce the aqueous carbonate solution for reuse in the absorption step and to produce hydrogen sulfide which may be converted into elemental sulfur by well known means, if desired.

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

REFER ALSO TO CITATION(S) 24979

24987 (UCID—17315(Pt.1)) Survey of data bases at the transportation systems center, U.S. Department of Transportation: Part I. Digest of detailed data base descriptions. Birss, E.W.; Yeh, J.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Nov 1976. Contract W-7405-ENG-48. 51p. Dep. NTIS $4.50.

Lawrence Livermore Laboratory (LLL) surveyed transportation-related data bases in conjunction with the Transportation Systems Center of the U.S. Department of Transportation (DOT/TSC). This survey contributes to a nationwide data base directory that will help DOT/TSC users identify data resources. The information in Part 1 report provides an overview of the data bases available to the DOT/TSC community. This report is part of a LLL ongoing research contract with the Information Division of DOT/TSC.

24988 (UCID—17316(Pt.1)) Transportation-related data bases extracted from the national index of energy and environmental data bases: Part I. Digest of detailed data base descriptions. Birss, E.W.; Yeh, J.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Nov 1976. Contract W-7405-ENG-48. 133p. Dep. NTIS $6.00.

Lawrence Livermore Laboratory (LLL) extracted a set of 135 transportation-related data bases from a computerized national index of energy and environmental data bases. LLL had produced the national index for the Division of Biomedical and Environmental Research of the Energy Research and Development Administration (ERDA). Part 1 report, which contains a digest of the detailed transportation-related data base descriptions, is part of a LLL ongoing research contract with the Information Division of the Transportation Systems Center of the U.S. Department of Transportation. (DOT/TSC).

INTERNAL COMBUSTION ENGINES

24989 (UCID—17361) Numerical solution of the spray equation. Westbrook, C.K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Nov 1976. Contract W-7405-ENG-48. 40p. Dep. NTIS $4.00.

The spray equation has been solved numerically using a statistical approach. The method has been applied to physical systems where all three space coordinates are independent, in an internal combustion engine with asymmetric liquid fuel injection. For physical configurations in which some degree of symmetry exists, the numerical model is simplified, at a considerable savings in computer time. Difference equations are derived for the spray equation in one, two, and three dimensions. In three dimensions the equations are given in Cartesian and cylindrical coordinates. Quantities of physical interest which can be calculated from the droplet distribution function are defined. Coupling terms for use in combined spray-gas phase hydrodynamics models are derived, conserving the total mass, momentum, and energy of the two-phase system. The spray model is extended to allow for denser sprays in which the thin spray approximation is no longer valid.

SPARK-IGNITION

REFER ALSO TO CITATION(S) 24992, 24995

TURBINE

24990 (COO—2749-15) Baseline Gas Turbine Development Program. Fifteenth quarterly progress report. Schmidt, F.W.; Wagner, C.E. (Chrysler Corp., Detroit, Mich. (USA)). 30 Jul 1976. Contract E(11-1)-2749. 50p. Dep. NTIS $4.00.

Progress is reported for a research program to demonstrate an experimental gas turbine powered automobile which would meet the 1978 Federal Emissions Standards, have significantly improved fuel economy and be competitive in performance, reliability and potential manufacturing cost with the conventional piston engine powered, standard size American automobile. Chrysler Corporation's Sixth Generation Gas Turbine Engine, having been selected as most representative of the state-of-the-art at the beginning of this program, has been used as the Baseline Engine. This is a 4:1 pressure

ratio regenerative engine with variable power turbine nozzles which meets the .41 HC, 3.4 CO, 3.0 NOx grams/mile original 1975 emissions standards. Baseline vehicles are intermediate-size, 4-door sedans modified to accept the turbine engines. The Baseline cars are being actively utilized in a variety of Bicentennial/Energy related displays and demonstrations. All Baseline Engine improvement tasks have been completed. Emissions tests using COED coal derived fuel were conducted. The first Upgraded Engine was assembled, installed in a test cell, and initial test runs up to 70% speed were conducted. Control of the gas generator shaft instabilities which have resulted in failures of the gas lubricated bearing, was demonstrated by providing a low spring rate, squeeze film damping, and reducing the motion restraint caused by thrust loadings. The power turbine shaft dynamics fixture was run successfully to 60,000 rpm. Conversion of the production cars for the Upgraded Engine is continuing. The two four-door cars are nearly complete.

ELECTRIC-POWERED SYSTEMS

REFER ALSO TO CITATION(S) 24858, 24993

FLYWHEEL PROPULSION

REFER ALSO TO CITATION(S) 24856

VEHICLE DESIGN FACTORS

24991 Air intake apparatus for engine. Morita, S.; Wada, H. (to Toyo Industrial Co., Ltd.). Japanese Patent 1950-376. 10 Jan 1975. Filed date 23 May 1970. 2p. (In Japanese).

A device to regulate the fuel to air mixture during automobile operation is described. A bypassing air line equipped with a spring operated valve is installed to connect the air cleaner and engine intake. Excess air is supplied when the valve opens and the amount of air is varied with a cone shaped valve seat. When deceleration occurs, the decreased pressure within the cylinders effects opening of the valve allowing air enriched fuel mixture to enter the combustion chambers. Both afterburning and knocking due to inadequate fuel to air ratio can be prevented by the device. The device also reduces the unburned components in exhaust gas.

ENGINE SYSTEM

24992 Heat exchanger, particularly for a pre-chamber of an internal combustion engine and method for producing such a heat exchanger. Danis, L.J. (to Eaton Corp.). German(FRG) Patent 2,450,190/A/. 24 Apr 1975. 16p. (In German).

1 fig. Available from Dt. Patentamt, Muenchen (FRG).

A heat transfer element is described which may be heated quickly and which rapidly conducts heat. The device is especially suitable for a precombustion chamber of an internal combustion engine. A method for manufacturing such an element is also described. In order for the element to heat the mixture in the main combustion chamber as quickly as possible after a cold start, it consists of a material with a high capacity for conducting heat. The element is exposed to the hot combustion gases and must therefore show a high resistance to oxidation at high temperatures. The element has a core with a high capacity for conducting heat (copper) and a surface layer consisting of one of the following materials: aluminium, rich aluminium alloy, nickel, rich nickel alloy.

24993 Electric-powered vehicle with infinitely variable speed transmission. Dittrich, O. (P.I.V. Antrieb Werner Reimers K.G., Bad Homburg (Germany, F.R.)). *Foerdern Heben;* **26**: No. 7, 725-728(Jun 1976). (In German).

8 figs.

An infinitely variable speed transmission for electric-powered vehicles is described. This type of transmission enables torque conversion in the range 1:4. Thus, the tractive power required for starting and for driving up slopes is provided, while the driving speed on level ground is also increased. The infinitely variable transmission is adjusted at all speeds by a centrifugal speed governor so that the speed and thus also the current of the motor is kept constant. This working point is chosen in the most suitable region with regard to motor efficiency, heating-up and battery capacity.

EMISSION CONTROL

REFER ALSO TO CITATION(S) 24991

24994 Exhaust gas circulation apparatus. Shibano, K. (to Fuji Heavy Industry Co., Ltd.). Japanese Patent 1950-734. 10 Jan 1975. Filed date 21 May 1970. 3p. (In Japanese).

An exhaust gas recirculation apparatus is described. An exhaust gas recirculation tube is connected between the exhaust pipe and the intake tube and the opening of the tube; the amount of recirculated gas is regulated by a piston-type cycle control valve which is connected to the throttle valve of the carburetor through an arm. The arm is designed in a two-step linkage so that the cycle valve closes the recirculation tube when the throttle valve is at a fully opened angle and a small angle. Therefore, no exhaust gas recirculation occurs when the automobile is in full power, idling, or low running conditions. This prevents lowered engine power at these conditions.

NITROGEN OXIDES

REFER ALSO TO CITATION(S) 24990, 25001

24995 Second evaluation of the Yamaha lean combustion engine system. Ann Arbor, MI; Office of Air and Waste Management (1975). 7p.

Fuel economy and exhaust emissions tests were conducted on a Toyota Corolla equipped with a Yamaha lean combustion spark-ignition engine system. The lean combustion system includes a number of modifications to the carburetor, intake manifold, and cylinder head to improve the quality of the fuel-air mixture and the distribution of the mixture. Analysis of the exhaust emissions over the 1975 Federal Test Procedure, the Environmental Protection Agency Highway Cycle, and the steady state emissions test revealed that the Yamaha test car achieved 1977 Federal emissions standards of 0.41 g/mi for hydrocarbons, 3.4 g/mi for carbon monoxide, and 2.0 g/mi for nitrogen oxides. The vehicle also met the 1978 California standards. Fuel economy averaged 23.6 mi/gal over the 1975 Federal Test Procedure and 36.3 mi/gal over the EPA Highway Cycle.

24996 Prevention apparatus of harmful exhaust gases in internal combustion engine. Mizuno, A. Japanese Patent 1950-213. 7 Jan 1975. Filed date 24 Jan 1970. 6p. (In Japanese).

An emission control device designed for toxic gases, particularly carbon monoxide, during deceleration employs a mechanism for increasing air supply while reducing the fuel supply. An air inlet pipe with electromagnetic valve is connected to the intake manifold. When the vehicle speed or engine speed detector mechanism registers a certain set value, the fuel supply control mechanism is actuated, reducing the throttle valve opening. Simultaneously, the electromagnetic valve of the air inlet pipe is also actuated, and the valve is opened. In this device, during deceleration, the fuel supply is reduced while the air supply is increased, thus reducing the emission of toxic gases. In a second invention, the throttle valve is designed to close during deceleration, cutting off the fuel supply, while the electromagnetic valve is opened for injecting air.

24997 Exhaust gas recirculation apparatus. Moritani, H. (to Hitachi Manufacturing Co., Ltd.). Japanese Patent 1950-210. 7 Jan 1975. Filed date 11 Sep 1970. 3p. (In Japanese).

An auto exhaust gas recirculation device to reduce nitrogen oxides emission is described. It contains a recirculation control valve and an on-off exhaust gas intake valve, and between these two valves, a pressure control valve. The recrculation control valve is linked to a throttle valve on the carburetor. The pressure difference (thus flow difference) between the carburetor and recirculation tube regulates the opening of the pressure control valve, thus the recirculating gas ratio is kept constant regardless of the amount of intake of fresh air-fuel gas mixture.

CARBON MONOXIDE

REFER ALSO TO CITATION(S) 24990, 24995, 25001

HYDROCARBONS

REFER ALSO TO CITATION(S) 24990, 24995, 25001

24998 Method for the catalytic conversion of hydrocarbons. Sinfelt, J.H.; Carter, J.L. (to Exxon Research and Engineering Co.). German(FRG) Patent 2,438,953/A/. 27 Feb 1975. 20p. (In German).

Available from Dt. Patentamt, Muenchen (FRG).

A description is given of a method to catalytically convert hydrocarbons as well as to regenerate iridium containing hydrocarbon conversion catalysts, preferably coated on carriers, and especially deals with a method to regenerate those type of catalysts, which are thus deactivated in that they deposit carbon due to the contact with a hydrocarbon addition product.

ALTERNATIVE FUELS

REFER ALSO TO CITATION(S) 24990

24999 (BERC/RI—76/15) **Experimental results using methanol and methanol/gasoline blends as automotive engine fuel.** Allsup, J.R. (Energy Research and Development Administration, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Jan 1977. 87p. Dep. NTIS $5.00.

Comparative emission and fuel energy economy data were generated using 1975 model vehicles adjusted for gasoline fuel and using gasoline and gasoline blended with 5 and 10% methanol; tests were made at temperatures of 20°, 75°, and 100°F on a chassis dynamometer in a climate-controlled test chamber. Results suggest that emissions and fuel energy economy are generally affected to the extent that methanol addition affects air-fuel stoichiometry, fuel heat content, and fuel vapor pressure. The term "fuel energy economy" is used to denote calculations on the basis of fuel energy content in lieu of fuel quantity. Vehicle emissions and fuel economy were essentially unchanged during approximately 7,500 miles of road testing; no engine or fuel system component failures were encountered during that testing. Road octane measurements were made for the fuels containing 5, 10, and 15% methanol in base gasolines of 84, 87, and 91 research octane quality. Results show significantly better octane improvement in blending methanol with the lower octane fuels as compared with the improvement in blending with the higher octane fuels. Steady-state engine emission and fuel energy economy data were generated using a late model automotive engine fueled with 5, 10, 15, and 100% methanol/gasoline blend. Test variables and engine parametric adjustments included engine speed, exhaust gas recirculation rate, air-fuel ratio, ignition timing, and compression ratio. Results suggest that operation with pure methanol may allow use of high-compression engines to realize improved fuel energy economy with relatively low oxides of nitrogen emission.

25000 (N—76-17101) **Minimum energy, liquid hydrogen supersonic cruise vehicle study. Final report, 21 Apr—17 Oct 1975.** Brewer, G.D.; Morris, R.E. (Lockheed-California Co., Burbank (USA)). Oct 1975. Contract NAS2-8781. 178p. (NASA-CR—137776; LR—27347). NTIS $7.50.

The potential was examined of hydrogen-fueled supersonic vehicles designed for cruise at Mach 2.7 and at Mach 2.2. The aerodynamic, weight, and propulsion characteristics of a previously established design of a LH_2 fueled, Mach 2.7 supersonic cruise vehicle (SCV) were critically reviewed and updated. The design of a Mach 2.2 SCV was established on a corresponding basis. These baseline designs were then studied to determine the potential of minimizing energy expenditure in performing their design mission, and to explore the effect of fuel price and noise restriction on their design and operating performance. The baseline designs of LH_2 fueled aircraft were then compared with equivalent designs of jet A (conventional hydrocarbon) fueled SCV's. Use of liquid hydrogen for fuel for the subject aircraft provides significant advantages in performance, cost, noise, pollution, sonic boom, and energy utilization. (GRA)

25001 (PB—254238) **Effect of gasoline additives on gaseous emissions (Part II).** Hurn, R.W.; Cox, F.W.; Allsup, J.R. (Energy Research and Development Administration, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Feb 1976. Contract EPA-IAG-D4-0040;EPA-IAG-04-0453. 60p. (EPA—600/2-76-026). Dep. NTIS $4.50.

A study was conducted to determine the effects of nitrogen-containing fuel additives in gasoline on regulated and nonregulated automotive emissions. Methodology was developed to measure possible nitrogen-containing compounds and was used to analyze the emissions from a variety of cars without catalysts. No effects due to the additives could be discerned. Of the nonregulated nitrogen compounds analyzed, ammonia, amines, nitriles, nitrosoamines, and aryl nitro compounds were not detected; HCN, cyanogen, and alkyl nitro compounds were measured. Emission data are included from a rotary engine (Mazda), an air-cooled engine (Vokswagen), and two standard V-8 engines (Chevrolet and Ford). Six nitrogen-containing additives chosen for their common usage were tested.

25002 (ERDA-tr—238) **Developmental trends of hydrogen vehicles using hydride storage tanks.** Buchner, H.; Saeufferer, H. 1976. Translation of German report. 21p. Dep. NTIS $3.50.

The utilization of hydrogen-driven vehicles was not practical until quite recently owing to the voluminous, dangerous and energy-consuming hydrogen storage in gaseous or liquid form. only owing to the development of suitable metallic hydride storage tanks, i.e., with the help of alloys in which gaseous hydrogen is bound metallically in the lattice, does hydrogen propulsion make gains chiefly under the viewpoints of sparing petroleum reserves and its rising significance with respect to environmental pollution. For the last two years, hydrogen propulsion has been tested in connection with hydride storage tanks at Daimler-Benz in practical operation with small transport vehicles. A discussion is given of the Mercedes-Benz experimental hydride vehicle and the refueling of the tank with gaseous hydrogen. The results of the program show that hydrogen storage in metal hydrides demonstrates a series of system-specific advantages for practical propulsion of automobiles without harmful materials and that the relatively unfavorable weight ratio of the storage tank can be at least partially compensated in comparison to liquid hydrocarbons. The hydride tank takes on the following four functions simultaneously with a suitable hydride selection: (1) fuel supply; (2) air conditioning system; (3) heat storage for engine exhaust heat; and (4) water condensation. At the same time, the hydrogen vehicle with the hydride storage tank represents an extremely environmentally favorable transportation resource with operating ranges between 200 km and 400 km.

25003 **Replacement of petroleum. Deutsche Shell: no alternatives in sight for the near future.** *Bergbau;* **27**: No. 10, 413(Oct 1976). (In German).

Short communication only.

MATERIALS

REFER ALSO TO CITATION(S) 23912, 23913

25004 **Joint international magnetism and magnetic materials intermag conference, Pittsburgh, Pennsylvania, June 15—18, 1976.** Becker, J.J.; Lander, G.H. (eds.). New York; American Institute of Physics (1976). 414p. (CONF-760619—).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

Papers and abstracts of papers are presented concerning metals and alloys, transition metal systems, magnetoresistance, surfaces, fine particles, domain walls, bubble physics, semiconductors, magnetic insulators, rare earth systems, microwave devices, amorphous materials, and glasses. Sixty-one of the items were processed individually. (JRD)

METALS AND ALLOYS

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 24461, 25056

25005 (CONF-760829—50) **Joining NbTi superconductors by ultrasonic welding.** Hafstrom, J.W.; Killpatrick, D.H.; Niemann, R.C.; Purcell, J.R.; Thresh, H.R. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 4p. Dep. NTIS $3.50.

From Applied superconductivity conference; Stanford, California, United States of America (USA) (17 Aug 1976).

An important consideration in the design and construction of large, high-field, superconducting magnets is the capability to fabricate reliable, high-strength, low-resistance joints. A process for joining NbTi, copper stabilized, superconducting composites by ultrasonic welding is described. This process yields a joint strength comparable to that of the superconducting composite and a resistivity significantly lower than achieved by conventional soft soldering. The superconducting properties of the composite are not affected by the joining process. Scarfing the joint to maintain a constant conductor cross section does not degrade its electrical or mechanical properties. The application of the ultrasonic joining process, including process control, scarfing, and NDT procedures, in the construction of the superconducting magnet (U.S. SCMS) for the joint U. S. — Soviet MHD program is described.

25006 (IS-M—87) **Electromigration as a purification process.** Peterson, D.T. (Ames Lab., Iowa (USA)). 1976. Contract W-7405-ENG-82. 27p. (CONF-7609106—1). Dep. NTIS $4.00.

From AIME fall meeting; Niagra Falls, New York, United States of America (USA) (20 Sep 1976).

Purification of metals and alloys by electromigration has certain inherent advantages and some limitations. A very high degree of purification with regard to both substitutional and interstitial impurities can in some cases be achieved. In solid metals, it is quite simple and easily controlled. In the case of liquid metals, it is necessary to prevent fluid flow and mixing in order to achieve purification. Moderately high electric fields and current densities are required to produce a significant electromigration velocity, and this high current introduces size limitations on the specimen to be processed. The diffusion-related nature of electromigration also means that the process is relatively slow. The long exposure times at high temperature usually require either a very high vacuum or pure inert atmosphere environment. Prediction of the degree of purification which can be achieved on the basis of an ideal isothermal system is discussed. Calculation of the time required to reach the steady-state condition is shown. The effects of temperature gradients, impurity transfer to and from the electrodes, environmental contami-

nation, and solute precipitation are examined. Some examples of successful application of the method are cited, and possible avenues for future development are indicated. 3 figures.

25007 (RFP-Trans—214) **Influence of shape and current-density distribution of the electron beam of a welding machine on weld dimensions.** Boncoeur, M.; Rapin, M. Translated from *Mem. Sci. Rev. Metall.;* **66**: 57-65(1969). 12p. Dep. NTIS $3.50.

An experimental device is described with which the diameter of an electron beam can be measured for powers of less than 2.5 kW. The recordings obtained with this device provide the numerical values necessary for calculation of the current-density distribution of the beam in a given cross section, normal to its axis. Correlations are attempted between the characteristics of beams and those of welds for welding powers of 1.5 and 2.4 kW. It is shown that at constant power, speed, and welding distance, the depth of the weld is greater the more the energy of the beam is concentrated close to its axis. It is also postulated that the electron beam is deformed during welding and that it undergoes a constriction effect due to the cloud of positive ions surrounding it. As a result, the correlations between the characteristics of the beam, measured outside welding conditions, and the dimensions of welds cannot explain exactly the influence of focusing of the electron beam. However, it is difficult to measure the characteristics of a beam during a welding operation and the results ought to be of some interest to the experimenter. 12 figures.

25008 **Weld overlay cladding of stainless steel on the inside surface of pressure vessels.** Sata, T. (Hitachi Shipbuilding and Engineering Co. Ltd., Osaka (Japan)). *Hitachi Zosen Giho;* **36**: No. 4, 262-267(Dec 1975). (In Japanese).

Austenitic stainless steels are welded as claddings on the inside surface of pressure vessels for desulphurizing reactors or nuclear reactors for preventing corrosion. Little is known of the characteristics of such welding processes and the metallurgical behavior of weld metal. This paper describes results of metallurgical investigations on clad metals deposited by several automatic welding processes, and efficient welding processes adapted for various parts of pressure vessels. Three automatic single-layer welding processes have been found to deposit satisfactorily weld overlay claddings having adequate chemical composition and metallurgical properties.

25009 **Stability of A-15 compounds in multifilamentary superconducting wires.** Luhman, T.; Horigami, O.; Dew-Hughes, D. (Brookhaven National Lab., Upton, NY). *Appl. Polym. Symp.;* No. 29, 61-70(1976).

With the preeminence of A-15 superconducting multifilamentary wires in magnet technology, it has become important to understand the thermodynamic factors influencing the formation of these compounds under solid-state reaction conditions. The six systems Nb—Sn, Nb—Ga, Nb—Ge, Nb—Al, V—Si, and V—Ga were prepared as single filament bronze wires and heat treated in an attempt to precipitate the appropriate A-15 compound. The compounds observed to form were categorized using a formation temperature ratio (stability index) based on the melting temperatures of the constituents which make up the single filament composites. This study has led to several predictions regarding the formation of A-15 compounds using a solid-state bronze diffusion technique. The results of experimentation based on these predictions are presented.

25010 (UCRL-Trans—1534) **Investigation of mutual diffusion in the Nb—Ge—Al system.** Ronami, G.N.; Berezina, V.P. Oct 1976. Translated from pp 25-29 of Struktura i svoistva sverkhprovodyashchikh materialov, Izdatel'stvo Nauka, Moscow, 1974. 9p. Dep. NTIS $3.50.

Phase diagrams of the Nb—Ge and Nb—Al systems are presented. In order to produce diffusion layers of the ternary system Nb—Ge—Al, an Al—Ge mixture was placed in a niobium vessel whose mouth was plugged with a ground-glass niobium stopper, and the samples then were subjected to diffusion annealing at temperatures of 1600 and 1700°C with subsequent quenching in an argon atmosphere. The concentration curves from an analaysis of these diffusion layers are presented and discussed. The superconducting transition temperature was measured inductively. (MHR)

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 25021

25011 (RFP-Trans—220) **Solidification diagrams of alloys formed by two alkali metals: sodium-cesium alloys.** Rinck, M.E. Translated from *C. R. Hebd. Seances Acad. Sci.;* **199**: 1217-1219(1934). 4p. Dep. NTIS $3.50.

The thermal analysis of sodium—cesium mixtures is reported. Cesium was prepared by the action of calcium on pure cesium chloride. The melting point of the metal was determined to be 28.3°C. The solidification diagram shows a eutectic point (75 at. percent Cs, ~30°C) and a transition point (71 at. percent Cs, ~8°C). The molecular cryoscopic constant of Na was found to be 435. The molecular weight of sodium was determined. 1 figure (RWR)

25012 **Fine structure inversion of the 3d excited state of sodium.** Foley, H.M. (Columbia Univ., New York); Sternheimer, R.M. *Phys. Lett., A;* **55**: No. 5, 276-278(29 Dec 1975).

The observed inversion of the fine structure of the excited 3d state of the sodium atom explained as due to a second-order effect between the electrostatic dipole exchange interaction and the magnetic spin-orbit interaction acting on the core 2p electrons.

25013 **Effects of in-plane fields on ballistic overshoot in the gradient propagation of magnetic bubble domains.** De Luca, J.C.; Malozemoff, A.P. (IBM Research Center, Yorktown Heights, NY). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 151-153(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

Using high-speed photography the effects of an applied in-plane field H/sub p/ on the velocity and ballistic overshoot of S = 0 bubbles propagated by a pulsed field gradient in EuGa, CdTmGa, and SmCaGe garnet films was studied. Peaks appear in the velocity versus drive curve. These peaks shift to higher drives with increasing in-plane field. At drives below the peaks the velocity is roughly linear with drive with very few state changes and little or no ballistic overshoot. At drives above the peaks the velocity is saturated at a value which increases with in-plane field. In this range ballistic overshoot and state changes occur quite often, indicating that Bloch lines and Bloch points can be nucleated.

25014 **Anisotropy of conduction electron g-factor in Au using the de Haas—van Alphen effect.** Crabtree, G.W. (Argonne National Lab., IL); Windmiller, L.R.; Ketterson, J.B. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 22-24(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

Conduction electron g-factors in Au were measured by an absolute amplitude technique. The gain of the field modulation detection system was calibrated and absolute amplitudes were deduced from the size of the measured signal. g-factors were derived using measurements of the frequency, mass, and Dingle temperature and values of the curvature factor from both KKR phase shift and Fourier series parameterizations of the surface. The measured g factors show a large anisotropy, from a low of approximately 1.2 on the neck at [111] to a high of approximately 2.4 for belly and dogsbone orbits.

25015 **Disordered systems with short-range order.** Kaplan, T. (Oak Ridge National Lab., TN); Gray, L.J. *J. Phys., C (London);* **9**: L483-L487(1976).

A general theory for elementary excitations in disordered systems with short-range order has been developed. The theory is based upon an averaging formalism which is a generalization of an averaging technique introduced by Mookerjee. The mathematical formalism is illustrated for the case of electrons in a binary alloy with short-range order. Illustrative calculations for Markov chains are shown to compare well with essentially exact numerical calculations.

25016 **Crystal structure and magnetic properties of RCu_4Ag (R = rare earth) intermetallic compounds.** Takeshita, T.; Malik, S.K.; El-Attar, A.A.; Wallace, W.E. (Univ. of Pittsburgh). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 230-232(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The RCu_5 intermetallic compounds crystallize either in the cubic $AuBe_5$ type structure or in the hexagonal $CaCu_5$ structure depending upon the particular rare earth ion involved. The effect of substituting Ag for one Cu on the structure stability of RCu_5 compounds has been investigated. It is observed that the compounds RCu_4Ag (R = Nd to Tm) crystallize in the $AuBe_5$ type structure. The magnetization of these compounds with R = Nd to Ho has been studied in temperature range 4.2 to 300°K and in magnetic fields up to 21 kOe. The compounds with Nd, Sm, Gd and Tb are found to order antiferromagnetically with Neel temperature of 7, 7, 9 and 16.5°K, respectively. The Dy and Ho compounds exhibit ferromagnetic behavior in magnetic fields larger than about 1 kOe. In the paramagnetic region, the magnetic susceptibility of all the compounds except that of $SmCu_4Ag$ follows the Curie-Weiss law. The paramagnetic Curie temperatures of these compounds can be explained on the basis of RKKY theory with a suitable choice of the Fermi wave vector.

25017 **Growth induced anisotropy in sputtered GdCo films.** Esho, S.; Fujiwara, S. (Nippon Electric Co., Ltd., Kawasaki, Japan). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 331-333(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

Substrate bias effects on growth induced anisotropy in amorphous GdCo films have been investigated. Perpendicular anisotropy is induced with negative bias voltages higher than -30 V. The induced anisotropy constant has close relations with Ar content and film density. With increasing bias voltages, both anisotropy constant and Ar content increase. Film density changes from 8.7 to 6.9 gm/cm^3 for bias voltages of zero and -170 V, respectively. The change in density may result from Ar inclusion and resultant void formation. An electric field distortion near the substrate surface gives a weak in-plane anisotropy in addition to the perpendicular anisotropy. There is a critical thickness required to induce the perpendicular anisotropy at a given bias voltage. The critical thickness decreases with increasing bias voltages. The growth induced anisotropy of bias sputter deposited GdCo films could be explained by assuming shaped void formation.

25018 Structure of sputtered very thin films of Gd—Co and Gd—Co—Mo amorphous films. Graczyk, J.F. (IBM Watson Research Center, Yorktown Heights, NY). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 343-344(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The structure of very thin films of Gd-Co alloys sputtered onto substrates of NaCl held at room temperature was studied. The composition of these films ranged from .18 to .24 atom fraction of Gd and thickness from 80 to a maximum of 600 A. It was found that the structural intensity modulations, as a function of the momentum transfer vector parallel anti s parallel = 4π sin theta/lambda (A)$^{-1}$, are very similar for comparable film thicknesses and only weakly dependent on composition. The scattered electron intensity of the 80 to 200 A thick films show considerable difference to the intensity scattered from thicker films and to the x-ray data of Cargill and Wagner et al. These differences are in the ratio of the intensities of the first two amorphous haloes and the amplitude and shape of the modulations in the range of s from 3.7 to 7.8. For the thin films the ratio of I(2.05)/I(2.95) = .97 and for the thicker films this ratio reduces to 0.73. Similar qualitative results for the scattered intensity are also observed for the Gd-Co-Mo amorphous alloys. The radial distribution functions of the thin films have strong radial correlation peaks at r_1 = 2.50 A a weak peak at 3.17 A and a strong peak at 3.62 A. The remaining correlation peaks for higher r values can be qualitatively explained as distances arising from higher order pairs of the dense random packings of atoms. The radial distribution function of the thicker films shows an increase in the peak height at 3.17 A and a decrease of the peak at 3.62 A. It is concluded that the initial few layers of these amorphous films have a modified structure as compared with the thicker films. This is due to the high reactivity of Gd with O_2 which produces a large number of Gd-O pairs (r = 3.62 A), which decreases with increasing film thickness.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 24520, 24551

25019 (CONF-7609106—2) **Fatigue crack propagation in Types 304 and 308 stainless steel at elevated temperatures.** Raske, D.T.; Cheng, C.F. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 22p. Dep. NTIS $3.50.

From AIME fall meeting; Niagra Falls, New York, United States of America (USA) (20 Sep 1976).

The fatigue crack-growth resistance of Type 304 stainless steel base metal and Type 308 stainless steel weld metal at 593°C (1100°F) was investigated. Specimens of both materials in the as-received (or as-welded) and thermally aged conditions were tested. The crack-growth rates were found to be exponentially related to the stress-intensity factor range, ΔK. This relation, determined by regression analysis, was statistically appropriate and generally provided a good fit to the data. Confidence levels for new crack-growth rate observations were estimated, and comparisons of mean crack-growth rates were made. The results of the present investigation suggest the following conclusions: The fatigue crack-growth rates at 593°C (1100°F) in the Type 308 stainless steel metal are statistically lower than in the Type 304 stainless steel base metal in both the aged and as-welded (or as-received) conditions. Thermal aging at 593°C for 1000 h results in lower fatigue crack-growth rates in the base and weld metal tested at 593°C. Moreover, this difference in crack-growth rate was found to be greater than previously reported for lower-temperature tests. Load changes and hold periods at each crack-growth increment increase the scatter in results by a factor of approximately three.

25020 (Y—2062) **Effects of orientation on the rolling and recrystallization behavior of tantalum single crystals.** Snyder, W.B. Jr. (Oak Ridge Y-12 Plant, Tenn. (USA)). Dec 1976. Contract W-7405-ENG-26. 118p. Dep. NTIS $5.50.

Thesis.

Some deformed single crystals are more difficult to recrystallize than others. Tantalum single crystals were rolled unidirectionally at room temperature to a thickness reduction of 80 percent. Optical and electron metallography, X-ray line broadening and pole figure analyses, and microhardness testing were used to study the deformed, recovered, and recrystallized structures of these crystals. Crystal stability, reorientation, and deformation banding was interpreted in terms of the Taylor theory of plasticity as applied to pencil glide in body-centered-cubic metals. Experimental results were in partial agreement with the theory. Nucleation of recrystallization was found to occur by the polygonization and growth of dislocation cells originally present in the deformed structure. Impingement of these growing nuclei resulted in a fully recrystallized structure whose orientations were present in the deformed crystal.

25021 (ORNL-tr—4034) **Properties of type 1811 CrNi stainless steel and parent-like weld joints as related to high-temperature application.** Grosser, E.D.; te Heesen, E.; Lorenz, H. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bensberg/Koeln (Germany, F.R.)). 1974. Translation by R.G. Mansfield of AED-CONF—74-538-008. (CONF-741092—1). 14p. Dep. NTIS $3.50.

From 2. symposium on welding in nuclear engineering; Dusseldorf, F.R. Germany (23 Oct 1974).

With X 6 CrNi 1811 steel, an unstabilized austenitic steel for use at high temperatures was introduced. In application this steel has confirmed the good results obtained abroad with the comparable AISI 304 ss with respect to machining, welding behavior with the use of weld metal of the same type, and long- and short-term mechanical characteristics. The differences in mechanical behavior of the base metal and the welded joints due to the low content of delta-ferrite and the structure of the weld metal must be considered in special applications. The adoption in Germany of American design specifications for the high-temperature range for the base metal and especially for the welded joints makes further studies necessary on fatigue behavior and related problems. 19 figures.

25022 (ORNL-tr—4285) **Low cycle fatigue strength of some austenitic stainless steels at room temperature and elevated temperatures.** (Japan Atomic Energy Research Inst., Tokyo). Mar 1975. Translation by H. Kubota of JAERI—1237. 44p. Dep. NTIS $4.00.

Type 304, 316, and 316L stainless steels were tested from room temperature to 650°C using two kinds of bending test specimens. Particularly, Type 304 was tested at several cyclic rates and 550° and 650°C, and the effect of cyclic rate on its fatigue strength was investigated. Test results are summarized as follows: (1) The bending fatigue strength at room temperature test shows good agreement with the axial fatigue one, (2) Manson—Coffin's fatigue equation can be applied to the results, (3) the ratio of crack initiation to failure life becomes larger at higher stress level, and (4) the relation between crack propagation life and total strain range or elastic strain range are linear in log-log scale. This relation also agrees with the equations which were derived from some crack propagation laws. It was also observed at the elevated temperature test: (1) The reduction of fatigue strength is not noticeable below 500°C, but it is noted at higher temperature. (2) The cycle rate does not affect on fatigue strength in faster cyclic rate than 20 cpm and below 100,000 cycles life range. (3) Type 316 stainless steel shows better fatigue property than type 304 and 316L stainless steels. 30 figures.

25023 Ion microprobe study of the tensile failure of a Pt—Rh—W alloy. Christie, W.H.; Smith, D.H.; Inouye, H. (Oak Ridge National Lab., TN). *J. Radioanal. Chem.;* 32: 85-97(1976).

An ion microprobe has been used to identify silicon as the embrittling agent responsible for the tensile failure of a Pt—30Rh—8W alloy. Silicon was found to be segregated on the grain boundaries of the alloy, and to have a concentration gradient along them from the outer surfaces toward the interior of the sample.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 24318, 25017, 25020, 25065, 25104, 25597, 25598

25024 (CONF-750989—P3, pp 470-481) **Collection of deuterium on a uranium getter during dynamic flow conditions.** Folkers, C.L.; Singleton, M.F. Mar 1976.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (30 Sep 1975).

In Radiation effects and tritium technology for fusion reactors.

Uranium was studied as a getter material under varying flow conditions using a uranium trap designed to remove tritium from inert gases. The uranium trap can remove any hydrogen isotope from an inert gas. Mixtures of deuterium in argon were used at room temperatures. In the case of tritium, recovery is effected by heating

the trap. A special segmented trap was designed to prevent channeling and to promote maximum reaction rates when gas flows through it. The gas mixtures were sampled at the trap inlet and outlet and were analyzed by a mass spectrometer. The results are expressed as a purification factor, which is the ratio of deuterium concentration at the inlet of the uranium trap to the concentration at the outlet. Purification factors vary inversely with both the ratio of deuterium to uranium already contained in the trap, and with the rate of flow of gas through the trap. The effects of varying inlet deuterium concentrations on purification factors are also discussed.

25025 (CONF-750989—P3, pp 482-506) **Tritium removal: a preliminary evaluation of several getters.** Schoenfelder, C.W.; West, L.A. (Sandia Labs., Livermore, CA). Mar 1976.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (30 Sep 1975).

In Radiation effects and tritium technology for fusion reactors.

The removal of hydrogen isotopes from flowing gas streams is an important aspect of CTR technology for both decontamination and tritium recovery from plasma exhausts. Several getters have been evaluated for their tritium scrubbing potential at the parts per billion level. Measurements of total capacity and dynamic response have been made for barium, erbium, palladium dispersed on molecular sieve, General Electric H-36 (zirconium alloy), Union Carbide Y-993 (Pd—MnO_2), Societa Apparecchi Electtrici e Scientifici Getters ST101 (Zr—Al), ST171, and ST181, and a Sandia developed organic material, dimerized phenyl propargyl ether (DPPE). Preliminary flow studies were conducted by passing mixtures of either hydrogen or deuterium diluted with argon through packed beds containing the getter and periodically sampling the effluent with a gas chromatograph sensitive to 500 ppB H_2. The results of this work, similar flow experiments using tritium and total capacity measurements are presented in the text.

25026 (CONF-750989—P3, pp 539-553) **Chemical equilibrium studies of tritium—lithium and tritium—lithium alloy systems.** Smith, F.J.; Land, J.F.; Talbot, J.B.; Bell, J.T. (Oak Ridge National Lab., TN). Mar 1976.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (30 Sep 1975).

In Radiation effects and tritium technology for fusion reactors.

In deuterium—tritium fusion reactors currently under design, the production of tritium is accomplished by utilizing a lithium-bearing blanket. Lithium metal is presently the leading candidate for the blanket material, although molten Li_2BeF_4, solid Li—Al (50 to 50 at. %) alloy and other lithium-containing materials are distinct possibilities. This paper summarizes progress of ongoing studies of the thermodynamics of some of these lithium containing systems. The individual solubilities of hydrogen, deuterium, and tritium in lithium as a function of temperature (700 to 1000°C) and pressure are presented. Recent work with the solid alloy Li—Al (50 to 50 at. %) has shown that the tritium solubility between 400 and 600°C is low. When the tritium pressure was between 0.14 and 0.52 torr, the Li—Al samples contained only 1 to 4 ppM tritium.

25027 (CONF-7609108—1) **Conduction electron polarization, magnetization densities, and neutron magnetic form factors in metals.** Freeman, A.J. (Northwestern Univ., Evanston, Ill. (USA). Dept. of Physics; Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 36p. Dep. NTIS $4.00.

From Conference on itinerant-electron magnetism; Oxford, United Kingdom of Great Britain and Northern Ireland (UK) (13 Sep 1976).

Itinerant vs. localized descriptions of 3d, 4f and 5f electron states is discussed. Recent energy band determinations of conduction electron polarization and magnetization densities and predictions of neutron magnetic form factors in metals are described. Comparisons of theory with experiment show good agreement and confirm the range of validity of the energy band description.

25028 (COO—3028-27) **Deuterium transport through 304 and 304L stainless steel at low driving pressures and 15 keV deuteron bombardment. Final report.** Perkins, H.K.; Noda, T. (Princeton Univ., N.J. (USA). Dept. of Chemical Engineering). 1976. Contract EY-76-S-02-3028. 64p. Dep. NTIS $4.50.

The permeation rate of D_2 through 304 and 304L stainless steel for driving pressures 10^{-5} to 10^{-1} Pa (10^{-7} to 10^{-3} torr) were measured over the temperature range 650 to 1050°K. Two 51 mu m and one 127 mu m, 304 samples and one 127 mu m, electropolished 304L sample were studied. The steady-state permeation rate varied linearly with p/sup ½/ in the 10^{-2} to 10^{-1} Pa range but had a higher dependence below 10^{-3} Pa. The steady-state and transient data at 10^{-1} Pa were used to calculate the permeability phi = 1.9×10^{18} exp (-6300 T^{-1} °K) molecules D_2 cm^{-1} sec^{-1} Pa/-½/ and the diffusion coefficient D = 3.5×10^{-4} exp (-5100 T^{-1} °K) cm^2 sec^{-1}. The processes involved in permeation are discussed and time-dependent formulae for the permeation rate are given for a number of simple cases. Following thermal permeation experiments, permeation rates resulting from bombardment with a 10 mu amp, 15 keV deuteron beam were measured. A high transient permeation rate was observed which is attributed to a surface impedance to reemission which decreases under bombardment.

25029 (ORNL—5233) **Grain growth in Ir—0.3% W alloys.** Harasyn, D.E.; Schaffhauser, A.C. (Oak Ridge National Lab., Tenn. (USA)). Jan 1977. Contract W-7405-ENG-26. 27p. Dep. NTIS $4.00.

The fuel cladding material for isotope heat sources operating above 1300°C is currently an Ir—0.3 percent W alloy. The ductility of this material under high-temperature impact accident conditions is reduced by large grain sizes. Grain size as a function of time and temperature is required to determine the effects of high-temperature exposure during fabrication, assembly, ground testing, and operation of the heat source. The average grain diameter and the number of grains across the 0.64 mm (0.025 in.) cladding-wall thickness of several batches of Ir—0.3 percent W sheet is reported as a function of time at 1583 K (1310°C), 1688 K (1415°C), and 1808 K (1535°C) up to 2000 hr. Growth rates were measured both perpendicular and parallel to the sheet surface in longitudinal cross sections of sheet samples. In alloys with Th, Al, Fe, Ni, and Rh dopant additions, the grain structure was elongated and grain growth was retarded. Grain size was measured by the line intercept method and the data were described by the grain growth equation, $d^3 - d_0 2 = kt$. An activation energy for grain growth was determined for each batch, in both the perpendicular and parallel directions. Abnormal grain growth was not observed within the time and temperature ranges of this experiment.

25030 **Crystal field effects in rare earth compounds.** Luthi, B. (Rutgers—the State Univ., New Brunswick, NJ). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 7-12(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The effects of the crystal field on thermal properties in intermetallic rare earth compounds are reviewed. For substances where single ion effects are predominant, experimental results for the specific heat, thermal expansion, magnetic susceptibility, and elastic constants are given. All these thermodynamic derivatives show clear cut crystal field effects (TmSb). Coupling constants deduced from these measurements are discussed. For substance where the ions are interacting elastic constants are emphasized. Methods of determining quadrupole-quadrupole coupling constants g' from the temperature dependence of certain symmetry elastic constants (rare earth pnictides, TmCd, TmZn, $PrCu_3$) are described. It is argued that g' is in large part due to conduction electron aspherical Coulomb charge scattering. A valence fluctuation system (TmSe) is mentioned. Magnetic field effects on elastic constants are given, with particular emphasis on rotational strain effects.

25031 **Highly magnetostrictive rare earth alloys.** Clark, A.E. (Naval Surface Weapons Center, Silver Spring, MD). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 13(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

Large magnetostrictive effects found in rare earth—iron intermetallic compounds are examined. These compounds are finding applications in acoustic delay lines, variable frequency resonators, active millisecond valves, and micropositioning devices. (JRD)

25032 **Superconductivity: a probe of the magnetic state of local moments in metals.** Maple, M.B. (Univ. of California, San Diego, La Jolla). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 71(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The superconducting properties of exemplary matrix-impurity systems in the three distinct regimes of magnetic character of the impurity which have been identified are reviewed. The three regimes can be distinguished by the detailed behavior of the depressions of (1) the superconducting transition temperature T/sub c/ as a function of impurity concentration n and (2) the specific heat jump ΔC at T/sub c/ as a function of T/sub c/. These systematics of superconductivity in the presence of local moments appear to be sufficiently well established that it is possible to (1) ascertain whether the solute spin is long-lived (magnetic) or short-lived (nonmagnetic) compared to thermal fluctuation lifetimes at superconducting temperatures; (2) determine the sign and magnitude of the conduction electron-impurity spin exchange interaction parameter I and the temperature dependence of the exchange scattering of conduction electrons by long-lived solute spins, (3) derive, in favorable cases,

information pertaining to the energy level structure of rare earth ions in the crystalline electric field or their superconducting metallic host, and (4) observe magnetic-nonmagnetic transitions of an impurity induced by the application of an external pressure or variation of the composition of a binary alloy matrix.

25033 Analysis of calorimetrically observed superconducting transition-temperature enhancement in Ti—Mo(5 at. %)-based alloys. White, J.J.; Collings, E.W. (Battelle Columbus Labs., OH). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 75-77(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The low temperature specific heats of four alloys based on Ti-Mo(5 at. percent) have been measured and analyzed. The four samples were (1) as-quenched with a $\beta + \omega$ structure, T/sub c/ < 1.5°K, (2) compressively deformed with an α'' martensite structure, T/sub c/ = 3.2°K, (3) solution strengthened by 1 percent Al addition with an α' martensite structure, T/sub c/ = 3.1°K, and (4) solution strengthened by 3 percent Al addition with an α' martensite structure, T/sub c/ = 2.8°K. The analysis employed a nonlinear fit for the usual parameters plus an asymmetric distribution of transition temperatures to account for the transition rounding. The procedure to be described yields accurate values for T/sub c/, and an equivalent (or homogeneous) specific-heat-jump height, ΔC, which is an indicator of the fraction of material participating in the superconductivity. These results combined with earlier observations indicate that the martensite phase, whether produced by deformation or otherwise, is the seat of an enhanced superconducting transition-temperature.

25034 Critical current density and flux pinning in Nb_3Ge. Braginski, A.I.; Daniel, M.R.; Roland, G.W. (Westinghouse Research Labs., Pittsburgh). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 78-80(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

High self-field critical current densities, J/sub c/, of the order of 10^6 A/cm² between 4 and 14°K have been reported for chemical vapor deposited (CVD) films of Nb_3Ge. Results of J/sub c/ measurements in a wide field range and film composition analyses suggest that high values of J/sub c/ are due primarily to flux pinning on dispersed tetragonal (sigma) phase. Single phase (A15) Nb_3Ge samples exhibited lower J/sub c/ of the order of 10^4 to 10^5 A/cm². The ac loss measurements corroborate the proposed interpretation.

25035 Effect of strain on the critical current of Nb_3Sn and NbTi multifilamentary composite wires. Ekin, J.W.; Clark, A.F. (National Bureau of Standards, Boulder, CO). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 81-83(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The critical currents of flexible Nb_3Sn and NbTi composite wires have been observed to decrease as a function of strain. Characteristic samples of the data are presented along with a brief summary and intercomparison of the results for each wire type. In the NbTi wires the decrease commenced at strains of about 0.5 percent, but did not become appreciable (i.e., greater than approximately 5 percent) until strains exceeded about 1.5 percent. The effect is almost totally reversible and the magnitude of the decrease is not strongly dependent on sample configuration or stabilization material. In the Nb_3Sn composites the degradation in critical current is relatively much larger, becoming significant at strains ranging from 0.1 percent to 0.3 percent depending on the reinforcement technique used in the wires' construction. At high strains, the effect in Nb_3Sn is only partially reversible. Also in the Nb_3Sn composites, stress-induced resistivities as high as 10^{-10} ncm were observed at currents well below I/sub c/. This leads to significant Joule heating of the superconducting wire and ambiguities in the operational definition of "critical current."

25036 Valency and magnetic behavior of ytterbium in intermetallic compounds. Klaasse, J.C.P.; Mattens, W.C.M.; van Ommen, A.H.; de Boer, F.R.; de Chatel, P.F. (Univ., Amsterdam). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 184-186(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

Seventeen binary and some ternary intermetallic compounds of Yb were examined in order to determine the factors controlling its valency. From susceptibility measurements between 1.4 and 1060°K the trivalent state can be firmly established by the validity of the Curie-Weiss law in 7 systems. Diamagnetism or weakly temperature dependent paramagnetism, indicative of divalent Yb, is found in 7 systems. In $YbGa_2$ and especially $YbCu_2$ the temperature dependence is too strong to classify these systems as simple Pauli paramagnets, and in $YbAl_2$, $YbAl_3$ and YbCuAl the susceptibility goes through a maximum and becomes Curie-Weiss like at high temperatures. Yb in the latter five systems is considered having an intermediate valency. A correlation is established between the valency of Yb and the electronegativity of its metallic environment. The temperature dependence of the susceptibility of the intermediate-valency systems can be reasonably described by invoking a 4f resonance on each Yb ion, but the complete lack of saturation cannot be understood within this picture. Other semi-empirical and theoretical formulas are also partially successful, but none of them offers a complete description of the results.

25037 Theory of variation from localized to itinerant magnetism in cubic intermetallic actinide compounds. Robinson, J.M. (Indiana Univ., Fort Wayne). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 189-191(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The Fermion excitation spectrum of a cubic crystal of actinide ions with partly filled 5f shells is derived. The crystal field and intraatomic interactions are assumed to be large compared with the one-electron interatomic hopping energy, so that Hubbard's "atomic representation" is valid. The magnetic moment, the magnetic susceptibility, and the fractional valence of the actinide ions are calculated as functions of the temperature, the external (or internal) magnetic field, and the f-f hopping energy. Assuming that the latter energy increases with decreasing lattice constant, results in qualitative agreement are found with the variation from localized to itinerant magnetic behavior observed in intermetallic actinide compounds.

25038 Magnetic neutron scattering on the intermediate valence system $CePd_3$. Holland-Moritz, E. (Kernforschungsanlage, Juelich, Ger.); Loewenhaupt, M.; Schmatz W.; Wohlleben, D. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 195(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

$CePd_3$ is an intermediate valence intermetallic compound / 1,2/ fluctuating between a nonmagnetic Ce^{4+} ($4f^0$, J = 0) and a magnetic Ce^{3+} ($4f^1$, J = 5/2) state. Measurements of the diffuse neutron scattering cross-section with TOF-analysis at several angles in the temperature interval 3.5 to 300°K are reported. A quasielastic magnetic line with 4f formfactor is found along with an abnormally large, nearly temperature independent width (GAMMA/2 = 18+-2 MeV at 240°K). The lower the temperature the more the measured magnetic cross-section is reduced compared with the value calculated on the assumption that all Ce-ions are in the $4f^1$ (Ce^{3+}) state (Curie-susceptibility). However, the cross-section is consistent with the actually measured, nearly temperature independent static susceptibility.

25039 Specific heat and electrical properties of the spin fluctuation system U/sub 1-x/Th/sub x/Al_2. Trainor, R.J.; Brodsky, M.B.; Culbert, H.V. (Argonne National Lab., IL). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 224-226(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The pseudobinary intermetallic compounds U/sub 1-x/Th/sub x/Al_2 have been studied by specific heat (2 to 30°K) and electrical resistivity (1.5 to 300°K) measurements for x = 0.0, 0.02, 0.05, 0.10 and 0.95. The specific heat of UAl_2 contains a large linear term indicative of a very high density of states at the Fermi level and a pronounced T^3 log T contribution due to ferromagnetic spin fluctuations. With increasing x, the specific heats show both an increase in the magnitude of the linear term and a strong modification of the T^3 log T term. The T^2 resistivity in UAl_2 changes to a T/sup 3/2/ dependence by x = 0.10. These effects are discussed in terms of reduced overlap of 5f wave-functions and increased impurity scattering with increasing x. The specific heat of the x = 0.95 sample exhibits a strongly field-dependent maximum near 2°K associated with interactions between local moments formed on the U sites.

25040 de Haas—van Alphen effect and the band structure of UGe_3. Arko, A.J.; Koelling, D.D. (Argonne National Lab., IL). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 227-229(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

De Haas-van Alphen measurements and band structure calculations are reported for UGe_3, a compound characterized by spin-

fluctuation phenomena. Only a partial construction of the Fermi surface is possible from the complex experimental data. Band structure calculations are at present plagued by numerical difficulties but, while not agreeing in detail with the data, nevertheless do show some of the features of the Fermi surface. Considerable structure in N(E) is predicted within 0.1 eV of E/sub F/. Large mass enhancements in UGe_3 are implied by these preliminary results.

25041 Magnetic properties of R(Fe/sub 1-x/Mn/sub x/)$_2$ compounds (R = Gd, Tb, Dy, Ho, or Er). Merches, M. (Univ. of Pittsburgh); Narasimhan, K.S.V.L.; Wallace, W.E.; Ilyushin, A. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 233-235(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

RFe_2 compounds crystallize in the cubic $MgCu_2$ type structure whereas RMn_2 compounds crystallize in the cubic structure when R = Gd, Tb, Dy and hexagonal $MgZn_2$ type of structure when R = Ho or Er. Solid solution between RFe_2 and RMn_2 was studied using x-ray, magnetic and Moessbauer investigations. When R = Tb and Dy complete homogeneity exists between the end members whereas when R = Gd, Ho, or Er only a limited solubility is found. Saturation magnetization at 4.2°K reveals that the moment increases when x is increased whereas the Curie temperature decreases. Magnetization versus temperature on the substituted ternaries revealed the presence of a broad maximum at low temperatures with a very small moment at the lowest temperature measured. This maximum is not present when the specimen is cooled in a field.

25042 Magnetic properties of some rare earth silicides of the type RFe_2Si_2. Sankar, S.G. (Univ. of Pittsburgh); Malik, S.K.; Rao, V.U.S.; Obermyer, R. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 236-238(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

RFe_2Si_2 compounds (where R = Rare Earth, Y or Th) crystallize in tetragonal $BaAl_4$-type structure. Magnetic properties of these compounds with R = Y, Tb, Ho and Er have been examined in the temperature range 4.2 to 950°K. $TbFe_2Si_2$ exhibits a Neel temperature of 5.5°K indicating that the rare earth sublattice orders antiferromagnetically. In $HoFe_2Si_2$ and $ErFe_2Si_2$, the rare earth sublattice does not order at temperatures down to 4.2°K. The iron sublattice orders magnetically at nearly 800°K in all the compounds investigated. Saturation magnetization studies on YFe_2Si_2 indicate partial ordering of iron moments confirming earlier work that a majority of iron atoms are diamagnetic. Crystal field interactions seem to be significant in $TbFe_2Si_2$.

25043 Magnetic properties of amorphous rare earth-transition metal alloys containing a single magnetic species. Heiman, N.; Lee, K. (IBM Research Lab., San Jose, CA). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 319-321(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The analysis of magnetic data on most amorphous rare earth-transition metal binary alloys studied to date is complicated by the fact that both constituents are magnetic. To avoid this problem amorphous films of Gd/sub 1-x/Cu/sub x/, with x = 0.76, 0.82, 0.86 and Lu/1-x/, Fe/sub x/, La/sub 1-x/Fe/sub x/ and Y/sub 1-x/Fe/sub x/ with 0.67 less than x less than 0.85 were studied. The GdCu alloys have T/sub c/ = 53, 40, and 35°K implying a Gd-Gd exchange about $^1/_2$ that of Gd metal. Significant differences between the magnetic properties of LaFe, LuFe, and YFe alloys were observed. LaFe has a well defined T/sub c/ near 275°K whereas LuFe and YFe fail to exhibit well defined magnetic transitions. The bulk magnetization and the internal field are considerably higher for LaFe than for LuFe or YFe. These results suggest that the magnetic properties of the Fe depend strongly upon the size of the rare earth atom. This interpretation is supported by results for amorphous Nd-Fe alloys which also have high T/sub c/ and large H/sub INT/ since Nd also has a large atomic size.

25044 Magnetic order, cluster phenomena, and hyperfine structure in amorphous YFe_2. Pala, W.P. (American Univ., Washington, DC); Forester, D.W.; Segnan, R. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 322-324(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

Moessbauer spectra of ^{57}Fe measured in bulk-sputtered YFe_2 (a-YFe_2) display temperature dependent behavior characteristic of long-range magnetic order for T less than T/sub c/ = 55 +- 5°K. The spectral features are similar to those of other magnetically ordered amorphous rare-earth-Fe_2 (R-Fe_2) alloys. Spectral resolution is maintained up to T approximately equal 0.8 T/sub c/ with no evidence for superparamagnetic cluster phenomena. The average magnetic hyperfine field, anti H/sub eff/(T), closely follows an S = 1 Weiss molecular field dependence with anti H/sub eff/(5°K) = 233 kOe. This field is unexpectedly large and comparable with that measured in the heavy R-Fe_2 alloys. It does not follow the general trend of decreasing anti H/sub eff/(0) with decreasing rare-earth moment. The ordering scheme below T/sub c/ is similar to that in other R-Fe_2 alloys.

25045 Magnetic anisotropy in thermally evaporated Gd—Co. Onton, A.; Lee, K. (IBM Research Lab., San Jose, Ca). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 328-330(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The x-ray diffraction spectrum of thermally evaporated a-GdCo is reported and found to be similar to that of bias sputter deposited a-GdCo which possesses an easy axis of magnetization normal to the film plane. The thermally evaporated a-GdCo films are shown to possess magnetic anisotropy with K/sub u/ approximately equal to 5 x 10^6 erg/cm^3 (hard axis normal to the film plane). Off axis atomic incidence experiments show that the hard axis K/sub u/ can be tilted toward the direction of incidence. No significant easy axis of magnetic anisotropy in the columnar growth direction was found. The results are consistent with the origin of the magnetic anisotropy being magneto-structural (cf., magneto-crystalline) in thermally evaporated a-GdCo.

25046 Magnetic properties of bias-sputtered Gd/sub 1-x/Fe/sub x/ amorphous films. Zwingman, R.; Wilson, W.L. Jr.; Bourne, H.C. Jr. (Rice Univ., Houston, TX). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 334-336(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The room temperature magnetic properties of amorphous Gd/sub 1-x/Fe/sub x/ films prepared by dc biased rf sputtering are reported. For low magnetization films made at a fixed bias, the wall energies are found to be nearly constant, regardless of the film magnetization. Also, no trend in H/sub k/ or K/sub u/ versus $4\pi M$/sub s/ and little trend in K/sub u/ with bias voltage can be discerned. The uniaxial perpendicular anisotropy appears to be induced by compressive stresses from the glass substrates. Such stresses are attributed to the deposition process and not to thermal contraction effects between the film and the substrate. The exchange constant is estimated to be 1.8 x 10^{-7} erg/cm; the anisotropy energies are on the order of 4 x 10^4 erg/cc.

25047 Effect of substrate bias on the anisotropy in low voltage multitarget sputtered Gd—Co and Gd—Fe thin films. Covault, M.L. (Iowa State Univ., Ames); Doctor, S.R.; Comstock, C.S.; Bailey, D.M. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 337-339(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

A low voltage multitarget sputtering system was used to study binary films having the same composition, independent of the dc substrate bias, by applying separate voltages to each target. Using this technique Gd-Co films were obtained possessing a perpendicular anisotropy sufficient to cause the magnetization to be normal to the film plane under grounded substrate conditions as well as when negatively biased. However, when the substrates were allowed to electrically float only in-plane magnetization was observed. In contrast, Gd-Fe films possessing perpendicular anisotropy could be obtained with or without an applied dc bias. The preparation conditions and x-ray (FeK/sub α/ radiation) diffraction analysis of these films are reported and their significance to the origin of the net uniaxial anisotropy is discussed.

25048 Multiple-target method for sputtering amorphous films for bubble-domain devices. Burilla, C.T.; Bekebrede, W.R.; Smith, A.B. (Sperry Research Center, Sudbury, MA). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 340-342(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

Previously, sputtered amorphous metal alloys for bubble applications have ordinarily been prepared by standard sputtering techniques using a single target electrode. The deposition of these alloys is reported using a multiple target rf technique in which a separate target is used for each element contained in the alloy. One of the main advantages of this multiple-target approach is that the film composition can be easily changed by simply varying the

voltages applied to the elemental targets. In the apparatus, the centers of the targets are positioned on a 15 cm-radius circle. The platform holding the film substrate is on a 15 cm-long arm which can rotate about the center, thus bringing the sample successively under each target. The platform rotation rate is adjustable from 0 to 190 rpm. That this latter speed is sufficient to homogenize the alloys produced is demonstrated by measurements made of the uniaxial anisotropy constant in $Gd_{0.12}Co_{0.59}Cu_{0.29}$ films. The anisotropy is 6.0 x 10^5 ergs/cm^3 and independent of rotation rate above approximately 25 rpm, but it drops rapidly for slower rotation rates, reaching 1.8 x 10^5 ergs/cm^3 for 7 rpm. The film quality is equal to that of films made by conventional methods. Coercivities of a few oersteds in samples with stripe widths of 1 to 2 μm and magnetizations of 800 to 2800 G were observed.

25049 Magnetic and galvanomagnetic properties of amorphous thin film Gd—Fe—Ni alloys. McGuire, T.R.; Taylor, R.C.; Gambino, R.J. (IBM Watson Research Center, Yorktown Heights, NY). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 346-348(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

Amorphous films with composition $Gd_{18}Fe/sub\ 82-x/Ni/sub\ x/$ where x varies from 12 to 68 have been prepared by evaporation. By comparing Gd-Fe-Ni with binary Gd-Fe, Gd-Au and Y-Fe amorphous alloys using both magnetization and spontaneous Hall data we analyze Gd-Fe-Ni first as a two sublattice system of Gd and Fe-Ni followed by separate consideration of the Fe and Ni. Based on a small decrease associated with the Fe magnetization it is calculated that the magnetization of nickel is strongly dependent on the composition, showing a decrease in moment with increasing nickel content, diminishing to almost zero at 66 percent Ni. For all compositions the Hall coefficient of Ni is found to be negative. Gd also has a negative Hall coefficient while Fe is positive.

25050 Kerr and the Hall effect in amorphous magnetic films. Shirakawa, T.; Nakajima, Y.; Okamoto, K.; Matsushita, S.; Sakurai, Y. (Osaka Univ.). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 349-351(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The temperature dependences of the extraordinary Hall effect (EHE) and the polar Kerr effect (PKE) hysteresis loops are measured in amorphous rare-earth (RE) transition metal (TM) films. The polarity of each effect corresponds to that of its TM component. The temperature dependence of Hall voltage is similar to that of the Kerr rotation angle, and, in Gd-Co-Mo films, it is similar to that of Co sublattice moment calculated by Hasegawa's two sublattice model. From these results, both EHE and PKE in RE-TM films are considered to mainly associate with the TM sublattice moment.

25051 Evidence for split bands from electronic specific heat and electrical transport data in Fe—V and in other iron and nickel alloys. Berger, L. (Carnegie-Mellon Univ., Pittsburgh). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 355-357(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

In concentrated alloys where the nuclear charges or exchange fields of the components differ sufficiently, the coherent potential approximation predicts that each alloy component has its own 3d band, having minimal overlap with the 3d bands of other components. This "split-band model" applies well to the spin-down bands of fcc Ni—Fe, Ni—Fe—Cu, etc., and explains many of their properties. For example, several physical quantities exhibit anomalies when the Fermi level epsilon/sub F/ crosses the boundary T between nickel and iron bands. A systematic search for bcc iron-base alloy series where the spin-up band might be split, and where epsilon/sub F/ might cross a boundary T between bands, yields Fe—V. As expected, the electronic specific heat coefficient γ of Fe—V has a minimum when epsilon/sub F/ is at T, around 15 at. percent V. The electrical resistivity rho, the slope rho^{-1} d rho/dH, and the anomalous Hall coefficient R/sub s/ have sharp anomalies close by. The magnetoresistance Δ rho/rho_0 is unusually large in FeV. A scattering resonance in the solvent band close to T leads to large α = rho/sub up arrow//rho/sub down arrow/, hence to these large Δrho/rho_0. The observed decrease of $\Delta\mathrm{rho}/\mathrm{rho}_0$ when epsilon/sub F/ crosses T into the vanadium band reflects a decrease of value of the matrix elements of spin-orbit interaction. Similar series such as Fe—Cr, Fe--Mo, Fe—W, Fe—Ti, Fe—Nb, are also discussed.

25052 Critical neutron scattering experiments on USb. Lander, G.H. (Argonne National Lab., IL); Sparlin, D.M.; Vogt, O. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 380(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

Uranium antimonide (NaCl crystal structure) is a type I antiferromagnet (T/sub n/ = 241.2 +- 0.1°K) with moments in ferromagnetic (001) layers stacked antiferromagnetically +- +-. The spin direction is [001]. The critical neutron scattering has been measured from a single crystal as a function of temperature and reduced wave vector q. Below T/sub N/ the power law M/M/sub o/ = D(1-T/T/sub N/)/sup β/ holds for 10^{-3} less than or equal to 1-T/T/sub N/ less than or equal to 10^{-1} with D = 1.35 +- 0.05 and β = 0.32 +- 0.02, in agreement with theory for a three dimensional system. A detailed study of the scattering shows two unusual features. First, the transverse susceptibility [measured around the (001) point] is vanishingly small. Second, considerable anisotropy was detected in the longitudinal spin correlations, depending on whether directions parallel or perpendicular to the spin ordering direction, k_{11}/sup c/ and k_{11}/sup a/, respectively, are considered. Both correlation lengths vary as (T/T/sub N/-1)/sup ν/ where ν approximately 0.32 +- 0.01. For all T, k_{11}/sup c/ approximately $6k_{11}$/sup a/ suggesting the presence of anisotropic exchange. This arises from quadrupole—quadrupole interactions within the $GAMMA_8$ ground state of this $5f^2$ electron system.

25053 Evidence for the surface barrier in a high-kappa superconductor. Bussiere, J.F. (Brookhaven National Lab., Upton, N.Y. (USA)). *Phys. Lett., A;* **58**: No. 5, 343-346(20 Sep 1976).

The entry and exit of magnetic flux have been measured for Nb_3Sn in fields up to 9.5 kOe. The results indicate that the barrier is the most likely mechanism for surface currents in this high kappa material.

25054 (UCRL-Trans—1533) Superconducting properties of the Nb_3(Ga,Ge,Al) system. Kruglov, V.S.; Bychkov, Yu.F.; Tsunrun, V.L.; Cherkasov, N.A. Oct 1976. Translated from pp 19-24 of Struktura i svoistva sverkhprovodyashchikh materialov, Izdatel'stvo Nauka, Moscow, 1974. 10p. Dep. NTIS $3.50.

The studies were conducted on samples obtained by arc furnace melting of powder compacts of Nb, Al, and Ge and the comparatively fusible hardener $NbGa_3$. In all alloys the ratio of niobium to nontransition elements was 3:1. The intermetallic compounds Nb_3Ga, Nb_3Al, and Nb_3Ge have the same Cr_3Si structure and similar lattice parameters. The B phase is the principal phase in cast Nb—Ga—Al—Ge alloys, according to the results of x-ray and metallographic analyses. An induction study of the superconducting transition temperature showed that the maximum values of T/sub c/ were observed in the region of Nb_3Al-base alloys, and the critical temperature in this corner of the concentration triangle varies slightly with composition over quite a broad range of concentrations. Because of the lack of an appropriate theory at the present time no explanation can be given for the dependence of T/sub c/ on the Nb—Ga—Al—Ge composition of the alloys. Investigation of the dependence of T/sub c/ for Nb(Ga,Al,Ge) alloys on annealing temperature showed that the curves obtained for different Nb_3Al-base alloys were similar. The effect of alloying with small impurities (up to 5 at.percent with respect to niobium) of transition metals was elucidated. (MHR)

25055 (UCRL-Trans—1535) Investigation of effect of impurity atoms of transition elements Mo and W on kinetics of formation of the intermetallic compound Nb_3Sn and some of its superconducting parameters. Ronami, G.N.; Berezina, V.P.; Baranov, I.A.; Konovalov, N.T.; Andreev, M.V.; Zhgutova, T.V. Oct 1976. Translated from pp 35-45 of Struktura i svoistva sverkhprovodyashchikh materialov, Izdatel'stvo Nauka, Moscow, 1974. 15p. Dep. NTIS $3.50.

The studies were conducted on diffusion layers annealed at temperatures of 1350, 1500, and 1800°C. The composition, homogeneity, and number of phases were determined. The concentration curves obtained by analyzing a sample each of the Nb—W—Sn and Nb—Mo—Sn systems are presented. It is noted from these investigations that elements Mo and W penetrate well into the Nb_3Sn phase when introduced as impurities. A decrease in T/sub c/ is observed both for a niobium alloy with these elements and for the Nb_3Sn phase with these metals as impurity atoms. (MHR)

25056 (UCRL-Trans—1536) Investigation of effect of impurity atoms of transition elements Ti and Zr on the kinetics of formation of the intermetallic compound Nb_3Sn and on some of its superconducting parameters. Ronami, G.N.; Berezina, V.P.; Baranov, I.A.; Konovalov, N.T.; Andreev, M.V.; Zhgutova, T.V. Oct 1976. Translated from pp 45-56 of Struktura i svoistva sverkhprovodyashchikh materialov, Izdatel'stvo Nauka, Moscow, 1974. 18p. Dep. NTIS $3.50.

Investigations were conducted on diffusion layers produced by heat treatment of small sealed niobium vessels of an alloy of Nb with an impurity in a specified concentration filled with metallic tin. The impurity concentration ranged from 0.1 to 5 to 10 wt. percent. After annealing, quenching was carried out in an argon atmosphere. The homogenizing conditions and the concentration of the third-component in the original alloy with niobium are shown for each of the systems investigated. The studies were conducted on metallographic microsections of samples by electron-probe analysis. The com-

position, homogeneity, and number of phases obtained were determined by means of an MS-46 microanalyzer. The results are presented and analyzed. (MHR)

25057 (UCRL-Trans—1537) **Effect of samarium on the superconducting properties of the compounds Nb_3Sn and Nb_3Al.** Savitskii, E.M.; Baron, V.V.; Bychkova, M.I.; Sumarokov, V.N. Oct 1976. Translated from pp 57-62 of Struktura i svoistva sverkhprovodyashchikh materialov, Izdatel'stvo Nauka, Moscow, 1974. 10p. Dep. NTIS $3.50.

The alloys were melted in an arc furnace with a permanent electrode in a pure helium atmosphere and were studied as cast and as annealed by microstructural and x-ray analysis techniques. The variation of cell dimension, transition temperature, and microhardness is illustrated. (MHR)

25058 (UCRL-Trans—1538) **Structure and superconducting properties of ternary alloys based on metallic compounds.** Savitskii, E.M.; Baron, V.V.; Efimov, Yu.V.; Bychkova, M.I.; Myzenkova, L.F.; Sumarokov, V.N. Oct 1976. Translated from pp 77-84 of Struktura i svoistva sverkhprovodyashchikh materialov, Izdatel'stvo Nauka, Moscow, 1974. 12p. Dep. NTIS $3.50.

An investigation was undertaken of the change in T/sub c/ in different phase regions of ternary alloys based on the A15 structure: Nb_3Ga—Nb_3Ge, Nb_3Sn—Sm, Nb—Zr—Sn, V_3Si—Mn_3Si, and V_3Si—V_3 Ga. Results show that the T/sub c/ change obeys the fundamental laws of physicochemical analysis: T/sub c/ changes continuously with composition in ternary solid solutions, has a singular maximum upon the formation of a superconducting ternary compound, is constant for superconducting phases in the three-phase region, and changes in two-phase regions. 5 figures. (DLC)

25059 (UCRL-Trans—11192) **Shock adiabats at ultrahigh pressures.** Al'tshuler, L.V.; Kalitkin, N.N.; Kuz'mina, L.V.; Chekin, B.S. (AN SSSR, Moscow. Inst. Prikladnoj Matematiki). Nov 1976. Translation of USSR preprint. 20p. Dep. NTIS $3.50.

The Thomas-Fermi atomic model with quantum and exchange corrections was used to calculate the shock adiabats of 52 solid substances. Estimates indicate that the accuracy of the calculations is satisfactory at pressures above approximately 50 Mbar. For quartz and five metals (Al, Fe, Cu, Cd, Pb), based on the calculated adiabats and experimental data on shock compressions, interpolation adiabats were plotted which satisfactorily describe both the experimental range studied and the 1000-Mbar pressure range.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 23893, 24264, 24265

25060 **Protection of power reactor metal structures in the process of prolonged storage under atmospheric conditions.** Pavlova, F.S.; Lukasheva, T.A.; Ivanova, M.I. *Lakokrasoch. Mater. Ikh Primen.;* No. 3, 38-39(1976). (In Russian).

3 refs.; short communication only.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 24478

25061 (CONF-761146—1) **Damage energy and displacement cross sections: survey and sensitivity.** Doran, D.G.; Parkin, D.M.; Robinson, M.T. (Oak Ridge National Lab., Tenn. (USA)). Oct 1976. Contract W-7405-ENG-26. 18p. Dep. NTIS $3.50.

From IAEA technical committee meeting on radiation damage units; Harwell, United Kingdom of Great Britain and Northern Ireland (UK) (2 Nov 1976).

Calculations of damage energy and displacement cross sections using the recommendations of a 1972 IAEA Specialists' Meeting are reviewed. The sensitivity of the results to assumptions about electronic energy losses in cascade development and to different choices respecting the nuclear cross sections is indicated. For many metals, relative uncertainties and sensitivities in these areas are sufficiently small that adoption of standard displacement cross sections for neutron irradiations can be recommended.

25062 (COO—1367-75) **Investigation of dislocation motion by etch pit and yield stress in electron irradiated copper.** Meshii, M.; Wada, M. (Northwestern Univ., Evanston, Ill. (USA). Dept. of Materials Science and Engineering). 1976. Contract EY-76-S-02-1367. 5p. (CONF-760804—5). Dep. NTIS $3.50.

From 4. international conference on strength of metals and alloys; Nancy, France (30 Aug 1976).

The dislocation motion determined by the etch pit technique and the macroscopic stress-strain relation are examined in electron irradiated copper single crystals in the temperature range from 4.2 to 100°K. A good correlation is found between these two observations and the dislocation kinetics near the yield point was determined.

25063 (COO—3158-52) **Stage II recovery behavior of ion-irradiated Pt(Au) alloys.** Wei, C.Y.; Seidman, D.N. (Cornell Univ., Ithaca, N.Y. (USA)). Oct 1976. Contract EY-76-S-02-3158. 9p. (CONF-761027—11). Dep. NTIS $3.50.

From International conference on properties on atomic defects on metals; Argonne, Illinois, United States of America (USA) (18 Oct 1976).

Direct and visible evidence was obtained for long-range migration of self-interstitial atoms (SIAs) in Stage II of three different ion-irradiated platinum(gold) alloys (Pt/0.1 at% Au, Pt/0.62 at% Au and Pt/4.0 at% Au). Field-ion microscope (FIM) specimens of the alloys were irradiated in-situ with 30 keV W^+ or Pt^+ ions at a tip temperature of 35 to 40 K at approximately 2.10^{-9} torr. Direct observation of the surface of the FIM specimens during isochronal warming experiments to 100 K showed that a flux of SIAs crossed the specimen's surfaces between 40 and 100 K. The spectrum for each alloy consisted of two recovery peaks (substages II/sub B/ and II/sub C/). The results are explained on the basis of an impurity delayed diffusion mechanism employing a two-level trapping model.

25064 (LA—6629-MS) **Code package for calculation of damage effects of medium-energy protons in metal targets.** Coulter, C.A. (Los Alamos Scientific Lab., N.Mex. (USA)). Dec 1976. Contract W-7405-ENG-36. 14p. Dep. NTIS $3.50.

A program package was developed to calculate radiation damage effects produced in a metal target by protons in the 100-MeV to 3.5-GeV energy range. A detailed description is given of the control cards and data cards required to use the code package.

25065 **Influence of B atom diameter on annealing recovery rates of superconducting transition temperatures in irradiated A-15 (A_3B) compounds.** Luhman, T.; Sweedler, A.R. (Brookhaven National Lab., Upton, N.Y. (USA)). *Phys. Lett., A;* 58: No. 5, 355-356(20 Sep 1976).

It has recently been shown that the superconducting properties of Nb-base A-15 compounds, A_3B, are severely degraded when exposed to high-energy (E<1 MeV) neutron irradiation at ambient reactor temperatures. In each case, superconducting transition temperatures, Tsub(c), and the Bragg Williams order parameters, S, were observed to decrease steadily with irradiations in excess of 10^{18} nvt. During irradiation the A-15 structure is retained and subsequent isothermal annealing restores almost completely the compound's original Tsub(c) value. In this letter a correlation between B atom diameter and the recovery rates of Tsub(c) for the irradiated materials Nb_3Ge, Nb_3Ga, Nb_3Al and Nb_3Sn is reported.

25066 **Positron annihilation as a non-destructive monitor of radiation damage in reactor pressure vessel steels.** Gauster, W.B. (Sandia Labs., Albuquerque, N.Mex. (USA)). *J. Nucl. Mater.;* 62: No. 1, 118-120(Oct 1976).

The success of positron annihilation measurements in the investigation of neutron irradiation effects in pure metals provides strong motivation to use the technique to study irradiated reactor materials. In particular, the non-destructive nature and high sensitivity of positron annihilation suggest that it may be useful in continued monitoring of test specimens as a function of irradiation time and may provide an early warning for incipient material failure. In order to investigate this area of application, positron annihilation angular correlation measurements were performed on unirradiated and irradiated A302-B reactor pressure vessel steel samples.

CERAMICS, CERMETS, AND REFRACTORIES

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 24061, 24063, 24350

25067 **Process for producing uranium carbide spheroids.** Shennan, J.V.; Ford, L.H. (to UKAEA London Office). German(FRG) Patent 1,771018/B/. 29 Jul 1976. 10p. (In German).

4 tabs. Available from Dt. Patentamt, Muenchen (FRG).

The invention deals with a method to produce UC spheroids which are filled into molded bodies of fire-proof material for fuel elements. The UC fuel particles are doubly coated: a first thin layer of pyrolytic carbon is coated at low temperature (1,200-1,400°C), a second layer of fire-proof material (e.g. SiC) is coated at a higher temperature (above 1,500°C) which holds back the fission products. The process is explained in detail using an example.

STRUCTURE AND PHASE STUDIES

25068 **Interpretation of lattice diffusion in magnesium oxide.** Wuensch, B.J. (Massachusetts Inst. of Tech., Cambridge). pp 211-231 of In Mass transport phenomena in ceramics. Cooper, A.R. (ed.). New York; Plenum Publishing Corp. ([nd]).

Magnesium oxide single crystals of greatly improved quality have recently become available, and techniques which permit prep-

aration of diffusion specimens to temperatures as high as 2500°C have been developed. Data are available for cation and anion self-diffusion and tracer diffusion of 14 different impurity cations. Very different interpretations have been given these data. Magnitudes of experimental diffusion coefficients are in fairly good agreement in the few cases in which different investigators have examined a given system. Insofar as examined, cation tracer diffusion coefficients appear to be independent of atmosphere. Recent theoretical estimates put the enthalpy for Schottky defect formation at 7 to 8 eV while the best MgO crystals of which present growth techniques are capable cannot display intrinsic behavior at any temperature below their melting point unless H/sub f/ is less than 6 eV. Interdiffusion coefficients known to be controlled by cation vacancies extrapolate smoothly to tracer values at zero concentration. It is therefore felt that there is strong evidence that the tracer-type diffusion data obtained to date represent extrinsic diffusion controlled by chemically-created vacancies, with energies of motion of the order of 2 eV. Alternative interpretations hinge on hints of structure in Arrhenius plots which may or may not be significant.

25069 (ORNL-tr—4188(Draft)) **Chemical bonds and valence states of atoms in monocarbides and mononitrides of d-transition metals.** Kuz'menko, P.P. Translated by M. Gerrard from *Dopov. Akad. Nauk Ukr. RSR, Ser. B;* No. 11, 999-1003(1975). 6p. Dep. NTIS $3.50.

On the basis of the metallic bond model described earlier, the chemical bond and atomic valency in these phases are considered. It is shown that the character of the interatomic bond in nitrides and carbides is identical. Electron transfer between the components is absent. The form of the orbital intersection is established. Formation of NaCl- and WC-type structures is proved. The homogeneity regions are estimated, and the nature of the metallic properties and high durability of these materials is demonstrated.

25070 Unusual critical crossover behaviour at a structural phase transformation. Pynn, R.; Axe, J.D. (Brookhaven National Lab., Upton, NY). *J. Phys., C (London);* **9**: L199-L202(1976).

The temperature dependence of the order parameter associated with the structural transition in NbO_2 has been measured by neutron diffraction. For reduced temperatures in the range 5×10^{-3} approximately less than epsilon approximately less than 10^{-1} a power-law behavior is found with an exponent of $\beta = 0.19 +- 0.02$; in the region 1.5×10^{-3} less than epsilon less than 5×10^{-3} a value of $\beta = 0.4$ (+0.04, -0.07) is observed. It is suggested that this behavior may be ascribed to a simultaneous crossover in lattice and order-parameter dimensionalities.

25071 Spin-orientation phase transitions in cubic ferrimagnetic GdIG: magnetooptic and visual investigation. Eremenko, V.V.; Kharchenko, N.F.; Gnatchenko, S.L. (Physico-Technical Inst. of Low Temperatures, Kharkov). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 380(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The sharp and smooth magnetic transitions due to the magnetic field in the canting process of the magnetic sublattices of GdIG are investigated by measuring the Faraday rotation in the small section of the sample and by the visualization of the magnetic structure in the polarized light. The investigations were made near the magnetic compensation temperature at the orientation H along the [111] and [100] axes. The Faraday rotation of the different magnetic phases was measured in the vicinity of the phase transitions between the collinear and canted structures and also between different canted ones. The visual observations were used to construct the phase diagrams and the magnetic state coexistence regions. Particular attention was paid to the critical point (the case H parallel [100]). Above the definite field the transition between the low- and high-temperature noncollinear states occurs smoothly. The experimental results are compared with the calculations carried out in the molecular field approximation making allowance for the three-sublattice structure of GdIG.

25072 Phase equilibria in system U—Pu—W—C. Ugajin, M.; Abe, J.; Suzuki, Y.; Takahashi, I.; Kurihara, M. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 1, 36-39(Jan 1976).

Published in summary form only.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 24115, 24848

25073 Microstructure and magnetic properties of spinel ferrites. Mishra, R.K.; Thomas, G. (Univ. of California, Berkeley). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 66-68(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

Achieving suitable magnetic properties in ceramic ferrites through thermomechanical treatments rather than through varying the processing and fabrication parameters alone are investigated. The high temperature phase transformation in lithium ferrite ($LiFe_5O_8$) spinel and the defects in $LiFe_5O_8$ and $NiFe_2O_4$ are studied using high voltage transmission electron microscopy in an effort to characterize the microstructures. Results show that a dispersion of paramagnetic $LiFeO_2$ particles in $LiFe_5O_8$ matrix gives rise to increased squareness of the hysteresis curve and increased coercivity. Annealing treatments of sintered ferrites remove undesirable intragranular (100)1/4[110] cation stacking faults and improve hysteresis loop parameters.

25074 Growth reproducibility and temperature dependencies of the static properties of YSmLuCaFeGe garnet. Sumner, G.G.; Cox, W.R. (Texas Instruments Inc., Dallas). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 157-159(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

Over 300 garnet films of nominal composition $[Y_{1.6}Sm_{0.3}Lu_{0.3}Ca_{0.8}](Fe_{4.1}Ge_{0.9})O_{12}$ were prepared for 5 μm bubble device operation at 0.5 MHz from -25 to 75°C. Melt composition, run-to-run process control, as well as temperature and composition differentials required for reproducible growth are presented. The effects of charge imbalance and mobility changes on domain coercivity are discussed. The static bubble properties were measured from -30 to 100°C, and temperature coefficients of -0.2 percent/°C and -0.1 percent/°C were found for the bubble collapse field and material length, respectively. With domain wall coercivity as low as 0.1 Oe at 25°C and 0.4 Oe at -25°C and with $q < 4$ at 75°C, this material should be well suited for devices requiring moderate speed of operation over broad ranges of temperature.

25075 Thermal conductivity and thermal radiation properties of UO_2. Brandt, R.; Neuer, G. (Univ., Stuttgart). *J. Non-Equilib. Thermodyn.;* **1**: No. 1, 3-23(1976).

More than 300 publications have been reviewed for studying the thermal conductivity and the thermal radiation properties of UO_2. The temperature, the porosity, the uranium to oxygen ratio and irradiation effects have an important influence on the thermal conductivity. The thermal conductivity of stoichiometric UO_2 with nearly theoretical density is well known up to the melting point with a maximum uncertainty of +- 15 percent. Relations can be established to calculate the conductivity of porous UO_2. The correlation between the conductivity and the O/U ratio could not be described analytically but the qualitative dependence is evident. Only a few publications could be found on thermal radiation properties of UO_2; most of them are investigating the radiation transport through solid fuel. Emittance data are therefore quite speculative. The total emittance and the spectral emittance might be approximately 0.9, and not significantly dependent on temperature and porosity or surface roughness.

25076 Tritium diffusion in ceramic materials for thermonuclear reactors. Fowler, J.D. Jr.; Causey, R.A.; Chandra, D.; Elleman, T.S.; Verghese, K. (North Carolina State Univ., Raleigh). *J. Vac. Sci. Technol.;* **13**: No. 1, 401-402(1976).

Tritium diffusion coefficients have been measured in ceramic materials of potential interest as insulator or wall materials in controlled thermonuclear reactors. Tritium was recoil injected into samples to about 2×10^{14} atoms/cm^2 through thermal-neutron transmutation of a surface blanket of ^{6}Li-enriched Li_2CO_3 in the NCSU Pulstar research reactor. Diffusion coefficients were determined from measurement of the tritium release rate during postirradiation isothermal annealing. Released tritium was detected either with an internal-flow proportional counter using P-10 sweep gas or with an ion chamber using a 90 percent helium—10 percent hydrogen gas mixture. The total amount of tritium in a sample was determined by heating to successively higher temperatures until no further tritium was released.

25077 Magnetic properties of epitaxial YCaSmTmGeIG and SmTmIG with submicron bubbles. Yamaguchi, K.; Inoue, H.; Asama, K. (Fujitsu Labs. Ltd., Kawasaki, Japan). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 160-162(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The molar composition ratios in the melt, to support submicron diameter magnetic bubbles in a YCaSmTmGeIG system, have been investigated. Films of saturation magnetization 4πM/sub s/ ranging from 511 to 919 Gauss were grown on (111)-oriented GGG using conventional LPE dipping techniques. A stripe domain width S/sub w/ ranging from 1.31 to 0.71 μm and a collapse field H/sub o/ of 287 to 625 Oe for this garnet system have been obtained. Films

of SmTmIG, in which 4πM/sub s/ = 1378 Gauss, S/sub w/ = 0.56 μm, H/sub o/ = 900 Oe, were grown using similar techniques. From these experimental results growth-induced anisotropy was found to roughly approximate to the following empirical relation for a YCaSmTmGeIG system in which four ions were substituted on [24C] sites: K/sub u/(M/sub s/x) = K/sub uo/M/sub s/x/M/sub so/x/sub o/. Where K/sub uo/ and M/sub so/ are growth-induced anisotropy and saturation magnetization of SmTmIG, respectively. K/sub u/ and M/sub s/ are these notations for a YCaSmTmGeIG system. x is the variable related to the composition of Sm and Tm ions in this garnet system, while that for SmTmIG is defined as x/sub o/. This formulation is also found to be applicable in a YCaSmLuGeIG system.

25078 Growth atmosphere effects on Ca, Ge-substituted garnet LPE film bubble properties. Hibiya, T.; Makino, H.; Hidaka, Y. (Nippon Electric Co., Ltd., Kawasaki, Japan). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 163-165(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

Growth atmosphere effects on bubble properties for $(Ca,Lu,Sm,Y)_3(Fe,Ge)_5O_{12}$, $(Ca,Eu,Lu,Y)_3(Fe,Ge)_5O_{12}$ and $(Ca,Y)_3(Fe,Ge)_5O_{12}$ garnet LPE films grown on (111) GGG substrates have been investigated. Equilibrium between the melt and gas phase was achieved, by keeping the $PbO\text{-}B_2O_3$ fluxed melt in an $O_2\text{-}N_2$ mixed gas atmosphere. Film lattice parameter and 4πM/sub s/ linearly increase with oxygen partial pressure, $P(O_2)$, while Curie temperature and growth-induced uniaxial anisotropy decrease with increasing $P(O_2)$ for these garnets grown at approximately 900°C. However, at higher growth temperature (approximately 1000°C), the $P(O_2)$ dependence turns out to be less significant. Pt^{4+} substitution in the octahedral sites accompanied with Pb^{2+} in the dodecahedral sites accounts for these drastic changes in film properties.

25079 $(Lu,La,Y,Ca)_3(Ge,Fe)_5O_{12}$: a temperature compensated high mobility bubble garnet. Hiskes, R. (Hewlett-Packard Labs., Palo Alto, CA). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 166-167(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The $(Lu,La,Y,Ca)_3(Ge,Fe)_5O_{12}$ garnet system is useful for practical high speed bubble devices because it contains no rare earth ions which contribute to damping; yet a combination of growth and stress induced anisotropy provides a q greater than 7 for 6 μm diameter bubbles. The partial substitution of Lu^{3+} on octahedral sites allows manipulation of the Neel temperature between 180°C and 200°C, with attendant H/sub T/ adjustment to -0.20 percent/°C over a -20°C to +120°C temperature range to match a particular barium ferrite bias magnet. Defect free films of this composition grown by standard LPE techniques in a $PbO\text{-}B_2O_3$ solvent in the temperature range 930 to 1000°C exhibit a coercive force less than 0.4 Oe and bubble mobilities greater than 2600 cm/s-Oe as measured by the bubble translation technique. The magnetization can be adjusted as low as 125 Gauss for a 6 μm bubble to 190 Gauss for a 4 μm bubble, which lowers the pulse power requirements for bubble devices by a factor of four compared to that needed by competing Sm containing garnets.

25080 Faceting of $(YEuYbCa)_3(GeFe)_5O_{12}$ on LPE garnet films. Tominaga, H.; Sakai, M.; Hirai, I.; Yamaguchi, K. (Fujitsu Labs. Ltd., Kawasaki, Japan). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 168-169(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The correlations of the faceting on LPE films and the lattice mismatches between LPE films and GGG substrates were investigated, taking into consideration LPE growth conditions for $(YEuYbCa)_3(GeFe)_5O_{12}$ in a $PbO.B_2O_3$ flux. The facets in this garnet system appeared, even when the mismatches were very small. In the case of a small mismatch, it was found that the tendency to faceting increased with increase in the lattice constants of LPE films and decrease in their growth rate. However, no defects such as a dislocation were observed in the faceting on LPE films using the X-ray reflection topography method. The lattice mismatches caused no harmful effects to the characteristics of bubble domains such as magnetic domain wall coercivity, domain wall energy and mobility, and it also did not effect magnetic bubble propagation.

25081 Growth-induced anisotropy in bubble garnet films containing calcium. Wolfe, R.; LeCraw, R.C.; Blank, S.L.; Pierce, R.D. (Bell Labs., Murray Hill, NJ). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 172-174(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The growth-induced anisotropy, K/sub u/ measured on (111) LPE films of Eu/sub 3-x/Ca/sub x/Si/sub x/Fe/sub 5-x/O_{12} grown on $Sm_3Ga_5O_{12}$ substrates is large and positive (K/sub u/ = 4.0 to 8.1 x 10^4 ergs/cm^3 for x = 0.5). Many experiments have shown that K/sub u/ in Eu/sub 3-x/Y/sub x/Fe/sub 5-y/Ga/sub y/O_{12} films is also positive. In films of compositions $(YSmCa)_3(GeFe)_5O_{12}$, the effects of Ca and of Y on the growth-induced anisotropy are the same in sign and similar in magnitude. Since Ca^{2+} is larger in ionic radius than Eu^{3+} or Sm^{3+}, whereas Y^{3+} is smaller, the simple site selectivity model of growth-induced anisotropy would predict opposite signs of K/sub u/ for the Ca and Y additions. This contradiction shows that ionic radius is not the only relevant parameter which determines growth-induced anisotropy in garnets, although size differences have been shown to account for the observed effects within the rare earth series. The charge difference between the Ca^{2+} ions and the rare earth ions, or the pairing of Ca^{2+} and Ge^{4+} or Si^{4+} ions during crystal growth may influence the site preference of the Ca ions and the resulting anisotropy. The growth-induced anisotropy of the $Eu_{2.5}Ca_{0.5}Si_{0.5}Fe_{4.5}O_{12}$ film, grown at 835°C at a rate of 2 μm/min, annealed out after several hours at 900°C in oxygen. This temperature is much lower than the usual annealing temperatures of 1200 to 1300°C in O_2 which are required to reduce K/sub u/ in other bubble garnets. This is attributed to a high concentration of defects due to an imbalance in the Ca-Si concentrations in films grown at low temperatures and large growth rates.

25082 Magnetocrystalline anisotropy in (100) LPE EuIG:Pb films. Klokholm, E.; Plaskett, T.S.; Cronemeyer, D.C. (IBM Research Center, Yorktown Heights, NY). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 175-177(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

Previous work has shown that the incorporation of 5 wt. percent Pb in (100) LPE EuIG films results in a large positive uniaxial anisotropy. Similarly, it has been observed that Pb causes large changes in the magnetocrystalline anisotropy constant, K_1. On the tensile side of the lattice mismatch, Δa, (0-1.5 percent Pb), the magnitude of K_1 increases with decreasing Δa until at Δa = 0.0026, K_1 attains a value of -42,800 ergs/cm^3. On the compressive side, Δa less than 0, (Pb greater than 1.5 percent) the magnitude of K_1 decreases with increasing compressive Δa, reaching a value of -17,500 ergs/cm^3 at Δa = -0.013 (5 wt. percent Pb). There is a discontinuity in K_1 near Δa = 0. Approaching Δa = 0 from the tensile side, K_1 extrapolates to -45,000 ergs/cc, while the extrapolated value from the compressive side is -27,500 ergs/cm^3. Theory predicts a linear behavior for K_1 with elastic strain, the proportionality constant being related to the magnetostriction. The observed values of K_1 with lattice mismatch are non-linear and much larger than the values predicted by the theory. It appears therefore that the variation of K_1 with Pb content in (100) LPE EuIG films is not caused by epitaxial strains, but by a structural modification of the lattice.

25083 Microwave measurement of magnetic bubble collapse and stripout field. Mier, M.G. (Air Force Avionics Lab., Wright-Patterson AFB, OH); Swenson, H.W.S.; Wigen, P.E. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 178-183(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The first use of magnetic resonance apparatus for measurement of the bubble collapse field, H/sub col/, and the bubble stripout field, H/sub so/, is reported. A low field peak with a distinctive line shape is observed at applied fields corresponding to H/sub col/ (increasing field sweep) or H/sub so/ (decreasing field sweep). A standard EPR apparatus with a high-Q cavity was used at 9.52 GHz. H/sub col/ was determined over the temperature range -50 to 125°C and as a function of the field angle from perpendicular. These data were corroborated by vibrating sample magnetometer measurements. The ease of temperature control and the applicability to bubbles which are difficult to observe optically due to small size are attractive features of the microwave technique.

25084 Microwave conductivity of EuO and EuSe. Kaski, K. (Helsinki Univ. of Tech.); Kuivalainen, P.; Salo, T.; Stubb, H.; Stubb, T. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 187-188(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The conductivity and dielectric constant have been measured in the temperature range 1.7 to 300°K. Three samples have been studied: unannealed and annealed EuSe and unannealed EuO. At rom temperature the microwave conductivity is approximately 10^{-1}, 8.0×10^{-3} and 1.4×10^{-3} $(\Omega cm)^{-1}$ respectively, the corresponding dc-

conductivities being 3 x 10^{-1}, approximately 10^{-5} and 10^{-7} $(\Omega cm)^{-1}$. The strong temperature dependence of the dc-conductivity is not seen in the microwave conductivity. The dielectric constants obtained from the same measurements are 24.0 and 12.1 for EuO and EuSe, respectively. The strong frequency dependence of conductivity can possibly be explained by a hopping mechanism, which could depend on temperature and magnetic order.

25085 Antiferromagnetism in $NiNb_2O_6$. Yaeger, I. (Univ. of Manitoba, Winnipeg); Morrish, A.H.; Wanklyn, B.M. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 204(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The field induced magnetization and principal magnetic susceptibilities of flux grown $NiNb_2O_6$ single crystals were measured from ambient down to 1.4°K. At T/sub N/ = 6.0 +- 0.3°K an antiferromagnetic ordering was observed. An AF-PM phase transition was induced by external magnetic fields parallel to the crystallographic c axis in the temperature range below T/sub N/. The experimental results are interpreted in terms of anisotropic bilinear interactions between Ni^2 ions within the manifold of the ground term $^3A_2$. A two-sublattice uniaxial antiferromagnet model is used to describe the Ni^{2+} spins in the mean field approximation. The bilinear Ni^{2+}-Ni^{2+} interactions are essentially of the exchange type with a small dipolar contribution. Along all three orthorhombic directions the ferromagnetic intrasublattice interaction is found to be stronger than the intersublattice antiferromagnetic coupling. The Ni^{2+} g tensor, taken to be isotropic, is g = 2.4 +- 0.1 and the uniaxial anisotropy term -KS²/sub z/ in the effective spin Hamiltonian with S = 1 yields K = 7.9 +- 0.7 K/spin. The parameters obtained in the analysis of the susceptibility data are used to calculate the second order AF-PM phase boundary which is compared to the experimental one.

25086 Crystal field study of thermal and magnetic properties of Er^{3+} ion in thioindates. Taneja, S.P.; Vishwamittar; Puri, S.P. (Punjab Agricultural Univ., Ludhiana, India). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 210(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The crystal field parameters of $CdIn_2S_4$, $ZnIn_2S_4$, and $CdInGaS_4$ were determined by calculating the Schottky specific heat, g-values, and paramagnetic susceptibility. Expressions for the crystal field Hamiltonian, the g-values, and paramagnetic susceptibility are included. (JRD)

25087 Displacement of the Curie temperature of $FeBO_3$ under pressure. Wilson, D.M. (Univ. of Oklahoma, Norman). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 217-218(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The spontaneous magnetization of $FeBO_3$ crystallites was determined in the critical region as a function of hydrostatic pressure to 3 kbar. At each pressure this magnetization could be described by the scaling law using T/sub c/ and a pressure independent critical exponent β as parameters. The Curie temperature, obtained from the fit of the data to the scaling law, varied linearly with pressure and at a rate of 0.53 +- 0.03 k/bar. No evidence for any change in the canting angle with pressure was found.

25088 Two-magnon-scattering contributions to FMR linebroadening in polycrystalline garnets. Roeschmann, P. (Philips GmbH Forschungslaboratorium, Hamburg). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 253-258(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

Measurements of the FMR linewidth, ΔH, of different Walker modes and of the lineshift, delta f, of the UPR mode have been made as a function of frequency and temperature on spheres of polycrystalline garnets of pure YIG and CaVIn substituted YIG with reduced anisotropy field H/sub a/. The experimental results can be explained on the basis of anisotropy and porosity (p) induced two-magnon-scattering contributions, ΔH/sub a/ and ΔH/sub p/. Excellent quantitative agreement is found with Schlomann's theory for ΔH/sub a/ and delta f, apart from the region close to the top of the spinwave manifold (SWM). The deviations are related to the inhomogeneity ratio, (4πM/sub s//H/sub a/), and may be explained by the perturbation of the SWM, by approach to saturation effects, and by the density of magnetostatic modes (MSM) evaluated from numeric calculations. The frequency and field dependence of the separated porosity scattering contribution ΔH/sub p/ show an excellent quantitative agreement with ΔH/sub eff/ measurements reported by Vrehen, Broese van Groenou and Patton but contradict known theories. ΔH/sub p/ consists of a nearly field independent fraction arising from scattering to high-k states and a usually much larger fraction, showing a distinct dependence on cos THETA/sub o/ of low-k spinwaves. Possible coupling models, based on these results, are presented. The experimental findings provide a guide for the evaluation of H/sub a/ and p of polycrystalline ferrites from ΔH-measurements.

25089 Magnetoelastic surface wave attenuation in ferromagnetic conductors. Liu, Y.J. (American Univ., Washington, DC); Savage, H.T. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 262-264(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The effect of conductivity and magnetic damping on magnetoelastic Rayleigh-type surface wave propagation along a tangential saturating field in the [100] direction of a cubic ferromagnetic medium was studied. Potential utilization of highly magnetostrictive rare earth-iron alloys in current surface wave technologies was investigated. Material parameters appropriate to Ga-YIG have been used, and conductivity and magnetic damping were treated as parameters in sample calculations. Two "loss bands" of frequency near ferromagnetic resonance are pointed out in which propagation of surface waves is highly attenuating. The attenuation depends strongly on the conductivity and magnetic damping in the lower band, but is otherwise not a strong function of either parameter. To avoid complexities acoustic damping is set equal to zero in the present investigation.

25090 Improved microwave devices using narrow linewidth garnets. Guidevaux, J. (Thomas-CSF, Montreuil, France); Hermosin, A.; Sroussi, R. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 265-267(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

Two materials have been developed in a new class of polycrystalline microwave garnets with linewidth less than 10 oe. The compositions are $Y_{2.9}Ca_{0.1}Fe_{4.2}Ge_{0.1}In_{0.7}O_{12}$ and $Y_{1.6}Ca_{1.4}Fe_{3.9}V_{0.7}In_{0.4}O_{12}$. These new materials were used in coaxial and waveguide circulators, in different frequency bands between 3.7 and 8.5 GHz. The figure of merit of these circulators is about 600, to be compared with 200 for circulators equipped with classical garnets. As expected, the insertion losses have been lowered, typically they are less than 0.1 db. These circulators, in a four-port configuration, are very attractive for parametric amplifiers applications. The feasibility of magnetically tunable pass-band filters employing these polycrystalline materials is demonstrated.

25091 Delay lines based on magnetostatic volume waves in epitaxial YIG. Bardai, Z.M. (Univ. of Edinburgh); Adam, J.D.; Collins, J.H.; Parekh, J.P. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 268-270(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

This paper describes the realization and operation of a magnetostatic volume wave (MSVW) delay line utilizing an epitaxial YIG film which exhibits useful constant delay characteristics. The delay line comprises a normally magnetized YIG film which is separated from a ground plane by a dielectric layer. Experimental results have been obtained using a 4.5 μm thick LPE-grown YIG film and a 115 μm thick glass dielectric layer, with 30 μm wide and 3 mm long Al microstrip lines deposited on the latter to form input and output couplers. The device has exhibited, in agreement with theory, a constant delay of about 350 ns over a 200 MHz bandwidth in the 1 GHz to 5 GHz frequency range.

25092 Finite width effects on magnetostatic surface wave propagation. Patterson, R.W.; O'Keeffe, T.W. (Westinghouse Research Labs., Pittsburgh). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 271-273(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

A model is proposed for the propagation of magnetostatic surface waves in a layered structure consisting of a ground plane and a YIG film separated by a dielectric. The standard assumption of an infinite sample width is replaced with an assumption of a sinusoidal transverse distribution of rf fields. Instead of a single solution, a multiplicity of solutions is found, each with a distinct dispersion relation. Experimental observation of the first two finite-width modes is in excellent agreement with predicted results derived from the model.

25093 Magnetoelastic effects associated with elastic surface wave propagation in epitaxial garnet films. Volluet, G.; Desormiere, B.; Auld, B.A. (Thomson-CSF, Orsay, France). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 274-276(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

Surface wave delay lines have been fabricated on epitaxial garnet films, using a ZnO coating and interdigital transducers for elastic wave excitation. Amplitude and phase delay variations of the delayed signal have been measured as a function of an in-plane magnetic field, at frequencies of 210 MHz and 335 MHz. For pure YIG films, the strongest effects are observed when the films are not magnetically saturated, exhibiting stripe domain patterns. The observed absorptions are explained by the gyromagnetic resonances driven by the effective field associated with the elastic strains. This effective field was determined from the relevant terms of the magnetoelastic energy; the stripe domain resonances were computed only for a (1,0,0) oriented film. An "easy-plane" film of GdGa doped YIG was also used and good agreement was found between gyromagnetic resonances and acoustic absorptions. Also the motion of stripe domains induced by an elastic wave has been observed. The drift velocity has been measured as a function of incident power. A discussion of this new effect is given.

25094 New magnetoacoustic modes in YIG substrates. Komoriya, G. (State Univ. of New York, Stony Brook); Parekh, J.P. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 277-279(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

Previously unreported magnetoacoustic modes have been detected on the surface of a 1.5 x 0.1 cm^2 YIG disk. The waves were excited by meander-line pairs along the [100] and [011] directions on a (01 anti 1) surface. The meander line excited both a magnetoelastic Rayleigh wave and the new modes for both the [100] and [011] directions. A drop of water on the surface of the substrate was used to absorb the energy in the surface wave modes while the velocity and dispersion of the new mode were being examined. For the [100] direction the new modes were approximately 8bdm down from the surface wave, while for the case of the [011] direction nearly all of the energy was carried in the new modes. The velocity of the surface wave was (v/sub s//1.07) x (1 +- 0.015) (i.e., within 1.5 percent of the theoretical value) while the velocity of the first of the new modes was v/sub s/(1 +- 0.0) for the [100] direction and is dispersive for the [011] direction. If the excitation frequency is held constant the maximum amplitude of the new wave is excited at approximately 20 G above the magnetic field which produces the maximum excitation for the surface wave. For excitation along the [011] direction, the new wave splits into two modes for magnetic fields between 300 and 330 G. The new mode could also be excited by a Rayleigh wave produced by IDT's on a ZnO film for the [100] direction.

25095 Magnetostatic propagation for uniform normally-magnetized multilayer planar structures. Tsai, M.C.; Wu, H.J.; Owens, J.M.; Smith, C.V. Jr. (Univ. of Texas, Arlington). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 280-282(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

Magnetostatic propagation in layered structures with magnetization in the plane and perpendicular to the direction of propagation has been studied theoretically and experimentally. Problems in device application of this geometry include low power saturation levels and limited delay times for reasonable film sizes. Both problems are minimized by use of normal magnetization giving volume modes having isotropic propagation in the film plane. This work reports theoretical and experimental studies for a normally-magnetized ground plane-dielectric-YIG-dielectric-ground plane structure. The dispersion relation is derived for the magnetostatic limit and this geometry. This theory indicates that with at least one ground plane within a magnetostatic wavelength of the YIG, significant modification of the dispersion characteristic can be obtained. Nondispersive regions of approximately 10 percent bandwidths are predicted. Experimental studies with an LPE-YIG film thickness of 10 μm and a dielectric thickness of 8 to 20 times the YIG thickness show nondispersive propagation over bandwidths greater than 100 MHz at 1.6 GHz. Agreement between theory and experiment is good. Saturation characteristics are better than those of similar magnetostatic surface wave devices.

25096 Advances in ferromagnetic metallic glasses. Hasegawa, R.; O'Handley, R.C.; Mendelsohn, L.I. (Allied Chemical Corp., Morristown, NJ). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 298-303(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

Recent developments in transition metal glasses have resulted in the synthesis of an iron-rich glass (nominal composition, $Fe_{80}B_{20}$) in continuous ribbon form. The as-quenched glass shows a saturation moment of 1.99 μ/sub B//Fe atom at 4.2°K, an induction of 16 kG at 300°K, a ferromagnetic Curie temperature of 650°K, a saturation magnetostriction of 30 x 10^{-6}, and a coercivity H/sub c/ of about 100 MOe. Large domains, elongated parallel to the ribbon axis, are observed. Both Moessbauer and FMR data indicate that the magnetic anisotropy (K = 3 x 10^4 erg/cm^3) is in the ribbon plane. Evidence is presented that boron donates less electrons to the d-band of transition metal atoms compared with other glass-forming metalloids such as phosphorus. Some of the low-field properties include: the permeability at 20 G, μ(20) = 1,700, μ/sub max/ = 102,000 and core-loss, W approximately equals 0.3 to 0.4 watts/kg at f = 1 kHz and B/sub max/ = 1 kG. Field annealing results in improvements in these properties: A typical field-annealed toroid shows H/sub c/ approximately 40 mOe, μ(20) = 4,000, μ/sub max/ = 320,000 and W = 0.1 watts/kg at f = 1 kHz and B/sub max/ = 1 kG. These properties represent significant improvements over existing iron-base metallic glasses and their commercial crystalline alloy counterparts.

25097 Optical birefringence in $Dy_3Al_5O_{12}$(DAG) in fields along [111]. Dillon, J.F. Jr.; Talley, L.D.; Chen, E.Y. (Bell Labs., Murray Hill, NJ). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 388-390(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

In fields along [111] DAG approximates a very special Ising antiferromagnet—one in which applied fields couple to the antiferromagnetic order parameter (H/sub a/—M/sub s/ coupling). The linear magnetic birefringence of DAG in H parallel [111] with light traveling along [1 anti 1 0] (perpendicular to the field) was measured. The H/sub a/—M/sub s/ coupling allows us to produce antiferromagnetic DAG in either of the two time reversed states; A^+ which is absolutely stable in positive fields, and A^- which is only metastable. For these two states Δn(H/sub a/) is remarkably different (at 1.37°K and 3 kOe $\Delta n(A^+) - \Delta n(A^-) = 10^{-5}$). The metamagnetic transition, A^+ - P shows as a change in Δn of about .75 x 10^{-5}. These are the first measurements of linear magnetic birefringence across the A^+ - A^- and A - P transitions. Both contrasts are substantial and make possible microscopy of the mixed phase.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 24064, 24420

25098 Wall states in ion-implanted garnet films. Beaulieu, T.J. (IBM Corp., San Jose, CA); Brown, B.R.; Calhoun, B.A.; Hsu, T.; Malozemoff, A.P. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 138-143(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

A model is presented which explains the wall states and transitions between states observed for bubbles propagating under the influence of an in-plane field in ion-implanted garnet films. Nine transitions were identified in which the deflection angle changes, six of which are accounted for by switching of the capping layer and injection of a Bloch point (BP). It was necessary to invoke three different wall structures for S = +1 bubbles depending upon the relative orientation of bubble velocity and the in-plane field. Two different S = ½ bubbles containing one BP are identified which differ in location of the Bloch point and the associated capping structure. There is one state containing two vertical Bloch lines and two BP's, one on each line; and there is a single S = 0 state.

25099 Temperature dependence of the dynamic properties of S approximately equals 1 bubbles in YSmLuCaGe iron garnet films. Fontana, R.E. Jr.; Bullock, D.C. (Texas Instruments Inc., Dallas). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 170-171(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

Bubble velocity as a function of drive field for 5 micron diameter bubbles in Ne^+ ion implanted $(YSmLuCa)_3(FeGe)_5O_{12}$ films was measured over a 115°C temperature range from -40 to +75°C. From this translation data the bubble mobility, μ, and dynamic coercivity, H/sub c/, were determined. For material with a room temperature mobility of 500 cm/s-Oe, a mobility temperature coefficient of 1.1 percent/°C was calculated. Skew angle measurements were consistent with the identification of the S approximately equal to 1 bubble state as the only stable wall configuration over this temperature range.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 24742, 24946

CORROSION, EROSION, AND DEGRADATION

REFER ALSO TO CITATION(S) 23929, 24946

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 24724

OTHER MATERIALS

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 24665

STRUCTURE AND PHASE STUDIES

25100 Stoichiometry and structure of LiH up to 6.0 GPa and 820 K. Piwinskii, A.J.; Lilley, E.M.; Smith, G.S. (Lawrence Livermore Lab., CA). *Phys. Status Solidi (a);* **32**: K145-K146(1975).

Experimental investigations were conducted at pressures between 2.5 and 6.0 GPa in the temperature interval 500 to 820°K to determine (i) if LiH reacts further with hydrogen to form a quenchable, higher hydride, LiH/sub n/, where $n < 1$; and (ii) the pressure at which LiH transformed into the denser cesium-chloride structure. In addition to these experiments, the effects of time on LiH stoichiometry under these conditions were investigated. It was found that for pressures lower than 4 GPa, the basic LiH rock-salt structure was still observed. The most clearly defined results were obtained in an assembly consisting of a Ag—Pd inner capsule and a tantalum outer capsule at 5.0 GPa and 773°K. These conditions produced no change in the stoichiometry of normal LiH having the rock-salt structure. As a result of the investigation, it is concluded that up to 6.0 GPa and 820°K no change can be produced in LiH.

25101 Growth texture of polycrystalline silicon prepared by chemical vapor deposition. Pratt, B.; Kulkarni, S.; Pope, D.P.; Graham, C.D. Jr. (Univ. of Pennsylvania, Philadelphia). *J. Electrochem. Soc.;* **123**: No. 11, 1760-1762(Nov 1976).

The crystallographic texture of CVD polycrystalline silicon is found to be a very sharp (110) fiber texture, with the (110) direction parallel to the direction of growth, and with no preferred orientation about this axis. The texture does not appear to be influenced by the orientation of the rod from which growth starts. This (110) growth texture has also been found in silicon films grown by similar methods on various substrates. (5 figures)

PROPERTIES

REFER ALSO TO CITATION(S) 24789, 25024, 25025, 25026, 25492

25102 (TID—27321) **Modulated optical investigation of transition metal oxide electrocatalysts: TiO_2 and $SrTiO_3$.** Pollak, F.H.; Raccah, P.M.; Lu, S.M. (Yeshiva Univ., New York (USA). Belfer Graduate School of Science). Sep 1976. Contract EY-76-C-02-0016;SUB-379095-S. 13p. Dep. NTIS $3.50.

The electroreflectance (electric field-modulated reflectivity) spectrum of reduced n-type TiO_2 and n-type $SrTiO_3$ was investigated, particularly below the fundamental absorption edge (~3 eV). TiO_2 was studied in aqueous electrolyte, metal-semiconductor, and metal-oxide-semiconductor configurations while the $SrTiO_3$ was investigated only for aqueous electrolyte. Features were observed in the spectrum for $h\omega < 3$ eV which appear to be related to the defect states in TiO_2. It is found that this structure is strongly dependent on the applied bias electric field. One optical feature appears at about 1.7 eV, an energy region in which structure has been observed in various other measurements which are related to both bulk (optical transmission, photoconductivity) and surface (electro-chemical, electron loss spectroscopy) states. The relation between the bulk defect levels introduced by reduction and surface states is discussed. Results are interpreted in terms of a recent model of Morin and Wolfram for d-electron surface states in transition metal oxides. In $SrTiO_3$ the results appear to be related to interference effects in the space charge layer. (5 fig.) (DLC)

25103 Superconductivity in compounds with anti-Th_3P_4 structure. Hulliger, F.; Ott, H.R. (Technische Hochschule, Zurich). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 70-71(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The majority of the compounds with Th_3P_4 structure exhibit nonmetallic and/or ferro- or antiferromagnetic properties. Superconductivity in the metallic chalcogenides La_3X_4 (X = S, Se, Te) which contain one excess valence electron per formula unit was discovered recently and fairly high values for the critical temperature T/sub c/ were reported. The only nonmagnetic pnictides (thorium pnictides) are valence compounds and at least the phosphide and the arsenide are semiconductors. A large number of rare-earth pnictides of composition Ln_4Pn_3 adopt the anti-Th_3P_4 structure. Again most of these compounds order magnetically. Superconductivity was detected in the La-compounds below 1°K Changes of T/sub c/ by substituting part of the cations or the anions are investigated and discussed.

25104 Superconductivity of the hydrides and deuterides of HfV_2. Duffer, P.; Gualtieri, D.M.; Rao, V.U.S. (Univ. of Pittsburgh). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 72-74(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

Current interest in the superconductivity of metal hydrides and deuterides has encouraged an investigation of the influence of hydrogen and deuterium absorption on the crystallographic and superconducting properties of the C15 ($MgCu_2$-type) intermetallic compound, HfV_2. Room temperature absorption of hydrogen (H) and deuterium (D) by HfV_2 at 2.5 x 10^6 Pa. was found to produce alloys of the compositions $HfV_2H_{4.53}$ +- 0.02 and $HfV_2D_{4.55}$ +- 0.02 which were stable upon removal to air. These fully hydrided and deuterated alloys were brought to equilibrium in various mixtures with HfV_2 to produce a range of alloy concentrations. Within the limits of measurement, the lattice parameters of the hydrides and deuterides of the same concentration were found to be identical, and the lattice expansion arising from absorption was found to vary linearly with hydrogen or deuterium concentration. These specimens, which were powdered by the absorption process, were tested for superconductivity to the compositions $HfV_2H_{1.59}$ and $HfV_2D_{1.00}$ by an inductance bridge method. Alloying with hydrogen was found to decrease T/sub c/ by 4.7°K per mole of hydrogen per mole of HfV_2. The deuterides exhibit a more rapid decrease of T/sub c/ of 6.8°K per mole deuterium. Upper critical field measurements of $HfV_2D_{0.5}$ indicate a depression of H/sub c2/ in comparison to HfV_2. These characteristics of the hydrides and deuterides are discussed on the basis of their lattice and electronic properties.

25105 Magnetic properties of $CdCr_2Se_4$. Kalinnikov, V.T. (Inst. of General and Inorganic Chemistry, Moscow); Aminov, T.G.; Belov, K.P.; Koroleva, L.I.; Schalimova, M.A. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 192-194(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The dependence of magnetization, delta, and resistivity, rho, on temperature T and magnetic field H has been studied near Curie point and at somewhat higher temperatures for single crystals of $CdCr_2Se_4$ deficient in selenium or doped with indium or copper. The magnetic field has a pronounced effect on the T/sub c/ values determined by extrapolation of the steepest section of the delta(T)-curves to the temperature axis. Thus, an increase of the field strength from 0.9 to 12.7 kOe leads to a 20 to 30° high temperature shift of the Curie point. The delta(H) curves measured near T/sub c/ are characterized by critical field values in the vicinity of which magnetization increases stepwise by about 80 percent. Copper doped crystals exhibit thermomagnetic hysteresis and those containing indium show positive magnetic resistivity in the temperature region where the critical field phenomena are observed. The experimental data are explained by the formation of ferrons, that is ferromagnetic microregions, under the action of magnetic field. The ferrons which owe their stability to the s-d exchange and Coulomb attraction are supposed to be localized at non-ionized impurity atoms. The magnetic field induced transition from a paramagnetic state to that characterized by the presence of ferrons represents the first-order phase transition.

25106 Magnetic properties of the hydrides of selected rare-earth intermetallic compounds with transition metals. Gualtieri, D.M.; Narasimhan, K.S.V.L.; Wallace, W.E. (Univ. of Pittsburgh). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 219-221(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

$ErFe_2$, $TmFe_2$ and $HoFe_2$ have been found to form stable hydrides of composition $ErFe_2H_{3.9}$, $TmFe_2H_{4.3}$, and $HoFe_2H_{4.47}$ when exposed to hydrogen at 3.6 x 10^6 Pa at room temperature. X-ray diffraction reveals an expansion of the $ErFe_2$ lattice parameter from 7.282 +- 0.001 to 7.828 +- 0.001 A, the expansion of the $TmFe_2$ lattice parameter from 7.238 +- 0.001 to 7.839 +- 0.001 A, and the expansion of the $HoFe_2$ lattice parameter from 7.284 +- 0.001 to 7.880 +- 0.001 A with hydrogen absorption. Magnetization measurements as a function of temperature and field were made on these hydrides. The compensation temperature observed at 480°K for $ErFe_2$ and 233°K for $TmFe_2$ was shifted to 42°K and 8°K, respectively, upon hydriding. Magnetic moments measured at 4.2°K in an applied field of 120 kOe are 6.45 and 5.60 μ/sub B/FU for

$TmBe_3$ and $HoFe_3$, respectively. These large moments arise due to the reduction of the iron moment. Results on hydrides of $NdCo_5$ and $DyCo_{5-2}$ are also presented.

CORROSION, EROSION, AND DEGRADATION

25107 EPR studies of Dy^{3+} in the singlet-ground-state paramagnets, PrX and TmX (X = P, As, Sb). Sugawara, K. (Case Western Reserve Univ., Cleveland); Huang, C.Y. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 34, 248-249(1976).

From Joint international magnetism and magnetic materials intermag conference; Pittsburgh, Pennsylvania, United States of America (USA) (15 Jun 1976).

See CONF-760619—.

The EPR of Dy^{3+} diluted in singlet-ground-state paramagnets, PrX and TmX (X = P, As) from 5 to 50°K was investigated. The g-values at 5°K have been found to be 7.1 +- 0.2 and 9 +- 1 for PrAs and TmAs, respectively, and they approach the theoretical g-value for $GAMMA_6$, 6.6, at high temperatures (T approximately equal to 50°K). In the temperature range investigated, the observed g-shifts are proportional to the magnetic susceptibilities of the respective hosts. The position of the first-excited state of Dy^{3+} has been determined by comparing the temperature-dependent intensities of the Dy^{3+} EPR with those of Gd^{3+} impurities in the same host. The g-values of Dy^{3+} in PrP, PrSb, and TmP were also measured at 5°K. From the g-shifts at low temperatures the exchange coupling constants between Dy^{3+} and its surrounding rare-earth ions (Pr^{3+} and Tm^{3+}) were computed. The temperature variation of the linewidth of Dy^{3+} in PrAs is discussed.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 24391, 24408

25108 (RFP—2456) **Radiation stability of a hydrogen getter material (DPPE).** Kazanjian, A.R. (Atomics International Div., Golden, Colo. (USA). Rocky Flats Plant). 18 Oct 1976. Contract E(29-2)-3533. 8p. Dep. NTIS $4.00.

An investigation was made on a hydrogen getter material (DPPE) to determine its radiation stability. Such material has potential for nuclear industry applications. The material is composed of 75 percent of an unsaturated organic compound (1,6-diphenoxy-2,4-hexadiyne) and 25 percent catalyst (5 percent palladium on calcium carbonate). The radiation stability of this material and of the hydrogenated product was determined by exposing them to gamma radiation in air and vacuum and analyzing for radiolysis products and hydrogen capacity. The major products formed were phenol and carbon dioxide. Numerous solid compounds were also formed in much smaller yields. Product yields were much larger in air than in vacuum. Hydrogen uptake curves showed that the hydrogen capacity decreased appreciably after an absorbed dose of about 10^8 rads, and that irradiation is more detrimental in air than in vacuum. [For SI (metric) use: rads have been replaced by grays (Gy) and 1 gray = 1 joule per kilogram, and 10^8 rads = 1 megajoule per kilogram.]

CHEMISTRY

ANALYTICAL AND SEPARATIONS CHEMISTRY

25109 (HASL—300(Suppl.3)(Add.)) **HASL procedures manual.** Harley, J.H. (ed.). (Energy Research and Development Administration, New York (USA). Health and Safety Lab.). 1972. 141p. Dep. NTIS $6.00.

The HASL Procedures Manual contains the following sections: general; sampling; field measurements; radiochemical and radiometric analysis; chemical procedures; data section; and specifications. (LK)

ACTIVATION AND NUCLEAR REACTION PROCEDURES

REFER ALSO TO CITATION(S) 25253

25110 Nondestructive determination of boron and cadmium in environmental materials by thermal neutron-prompt γ-ray spectrometry. Gladney, E.S.; Jurney, E.T.; Curtis, D.B. (Los Alamos Scientific Lab., NM). *Anal. Chem.;* **48**: No. 14, 2139-2142(Dec 1976).

Prompt γ rays from thermal neutron induced nuclear reactions have been used to measure trace quantities of B and Cd in industrial and standard materials. The technique provides a rapid nondestructive analysis for < 0.05 μg of B. Repetitive analyses show the method to have a precision of 5%. The presence of large quantities of Na degrades the accuracy and precision of the B analysis. The technique also provides a method for the determination of Cd although it is not sufficiently sensitive to provide a practical alternative to more conventional methods.

25111 Determination of arsenic, tungsten, and antimony in natural waters by neutron activation and inorganic ion exchange. Gladney, E.S.; Owens, J.W. (Los Alamos Scientific Lab., NM). *Anal. Chem.;* **48**: No. 14, 2220-2222(Dec 1976).

Ion exchange on Al_2O_3 columns has been used to quantitatively measure As, Sb, and W in water. This procedure requires short thermal neutron irradiations; rapid ion exchange without chemical manipulations, and short γ-ray counts on a Ge(Li) detector. Precisions of +-5% can be routinely obtained and the following detection limits have been achieved: As, 0.05 ppb; Sb, 0.03 ppb; and W, 0.05 ppb.

CHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 24072, 25319

25112 (TID—27310) **Franck—Condon factors in studies of dynamics of chemical reactions. III. Analysis of information theory for vibration-rotation distributions and isotopic branching ratios.** Schatz, G.C.; Ross, J. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Chemistry). 1976. Contract EY-76-D-02-2873. 60p. Dep. NTIS $4.50.

A previously developed approximate theory of chemical dynamics based on generalized Franck-Condon factors is used to study the information theoretic analysis of vibration-rotation distributions and of isotopic branching ratios. We begin by examining the surprisal function I obtained from the Franck-Condon factors for rotational and vibrational distributions. For rotational distributions we find linear surprisal behavior for low rotational excitation in the limit of strong potential and weak kinematic coupling, but nonlinear surprisals for high rotational excitation in that limit. In addition, nonlinear rotational surprisals are generally obtained for any degree of rotational excitation in the limit of strong kinematic and weak potential coupling. We find these generalizations from the Franck-Condon factors and their applications to the $H + H_2$, $F + H_2(D_2)$ and $H + Cl_2$ reactions. For $F + H_2(D_2)$, nearly microcanonical rotational distributions are obtained (for low j^2). For vibrational distributions linear surprisals are obtained for $F + H_2(D_2)$, but not for $H(D) + Cl_2$. For both rotational and vibrational surprisals, we find that linearity occurs when the potential constrains the reaction to occur through a highly localized set of nuclear configurations. In our study of branching ratios, we consider the isotopic branching in F + HD yields FH(FD) + D(H). We first show that the purely dynamical Franck-Condon factor provides a correct qualitative description of the branching ratio (especially its dependence on reagent rotational excitation). We then use information theory to predict the same ratio.

25113 (RFP-Trans—215) **Selenium: its importance as oligoelement in animal feeding, microdetermination and sensibility comparison between polarographic and fluorimetric method.** Cirilli, G.; Rienzi, R.; Rocchi, R. Translated from *Tec. Molitoria;* **25**: 313-317(1974). 5p. Dep. NTIS $3.50.

Experimental results verifying the necessity for trace amounts of Se in chicken diet and the toxicity of the element in quantities above 5 to 7 ppM are summarized. The laboratory procedure for the polarographic and fluorimetric determination of Se is given. Problems with the fluorimetric method are cited, although its sensitivity is greater than that of the polarographic method. (JSR)

25114 Application of the blind assay to biological activity and tobacco smoke terpenes. Ho, C.H.; Griest, W.H.; Guerin, M.R. (Oak Ridge National Lab., TN). *Anal. Chem.;* **48**: No. 14, 2223-2226(Dec 1976).

The blind assay technique was applied to the chromatographic data generated from gas-liquid chromatography (GLC) profiles of terpene-enriched fractions from the total particulate matter (TPM) of eight experimental cigarettes. Correlation of the entire terpene fraction peak area and 16 individual peaks with data from three skin-painting bioassay parameters indicated that the terpene fraction as a whole and at least 12 of its constituents correlate well with biological activity. Six correlating peaks were tentatively identified as d-limonene, damascenone, norphytene, neophytadiene, phytol, and squalene. High correlations were also observed between the TPM concentrations of these constituents and the total terpene fraction. Of the terpenes visualized, d-limonene would act as the best indicator of the tobacco smoke biological activity.

25115 Detection limits of chemical spot tests toward certain carcinogens on metal, painted, and concrete surfaces. Weeks, R.W. Jr.; Dean, B.J.; Yasuda, S.K. (Los Alamos Scientific Lab., NM). *Anal. Chem.;* **48**: No. 14, 2227-2233(Dec 1976).

The formation of chromogenic and fluorogenic derivatives of certain aromatic amines designated by the Occupational Safety and Health Administration as cancer-suspect agents has allowed these compounds to be detected at very low levels through chemical spot

tests. Well-defined painted, metal, and concrete were used as standard surfaces to evaluate the limit of detection values of these compounds as a function of both the visualization reagent and the method of detection. The chromogenic reagent of choice was Ehrlich's reagent and the fluorogenic reagents were either fluorescamine or o-phthalaldehyde. The limit of detection values for these compounds in terms of grams of analyte per cm^2 of surface being analyzed ranged from the low nanogram to 5-μg level depending upon the compound, sampling technique, and surface involved. The combination of sampling technique and visualization reagent employed extend the limit of detection to levels considerably lower than previously reported.

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 25576

25116 (SAND—76-0154) **GEOPAC: a set of programs for on-line quantitative microprobe analysis of oxide-based specimens.** Chambers, W.F. (Sandia Labs., Albuquerque, N.Mex. (USA)). Apr 1976. Contract E(29-1)-789. 65p. Dep. NTIS $4.50.

A set of programs for on-line collection and quantitative reduction of microprobe data for oxide-based specimens which may contain up to 25 oxides was developed. The programs, written in the SANDIA-FOCAL language, control both spectrometer and stage motions in order to collect peak and background data in triads for a time sufficient to provide preset counting statistics. Values from intermediate triads are stored on disk until a complete data set has been collected; the data set is then reduced via a three-iteration Bence—Albee technique to stoichiometric oxides; and a summary of the composition and, where appropriate, a normative or endmember analysis are printed. Ninety-five percent confidence level limits are calculated and printed if more than one point has been analyzed.

25117 **Collection and analysis of radionuclides in seawater.** Silker, W.B. (Battelle Pacific Northwest Labs., Richland, WA). pp 139-149 of In Analytical methods in oceanography. Gibb, T.R.P Jr. (ed.). Washington, DC; American Chemical Society (1975).

^{7}Be and fission products from seawater are collected and their concentrations quantified by analysis. The basic sampling system consists of a unit which filters the water to remove particulate material and then directs the sample flow through a bed of aluminum oxide which retains a determinable amount of the various radionuclides. Fractional radionuclide adsorption was first evaluated in the laboratory under simulated field conditions and then verified by experiments at sea. Analysis of the samples is done by anticoincidence-shielded multidimensional gamma ray spectrometry, which provides a sensitive means of radionuclide detection.

SPECTRAL PROCEDURES

REFER ALSO TO CITATION(S) 23949, 25135, 25153, 25160, 25285, 25596

25118 **^{15}N nuclear magnetic resonance spectrum of alumichrome. Detection by a double resonance Fourier transform technique.** Llinas, M.; Horsley, W.J.; Klein, M.P. (Univ. of California, Berkeley). *J. Am. Chem. Soc.;* **98**: No. 24, 7554-7558(24 Nov 1976).

Alumichrome, the Al^{3+} analogue of ferrichrome, a ferric cyclohexapeptide, was enriched in ^{15}N by growing the fungus Ustilago sphaerogena in a medium containing 99.5% ^{15}N-ammonium acetate as the sole nitrogen source. The magnitude of the amide proton—nitrogen scalar coupling constant, obtained directly from the ^{1}H NMR spectrum is correlated with the angular deviation from planarity at the peptide bond. The ^{15}N amide resonanceees were measured indirectly by heteronuclear double resonance methods. The amide ^{1}H NMR spectrum was obtained by Fourier transform at 220 MHz while the ^{15}N resonances were irradiated selectively with low power near 22.3 MHz. The chemical shifts of the amide ^{15}N resonances are sensitive to conformation and the responses to temperature and solvent changes provide excellent criteria for determining the spatial configuration of each -NH—CO-group within the peptide structure. An extension of the Fourier transform double resonance method, Fourier internuclear difference spectroscopy (FINDS), was tested successfully on the amide region of the unenriched peptide thus permitting detection of ^{15}N resonances at natural abundance. The results suggest a large potential for the method.

SEPARATION PROCEDURES

REFER ALSO TO CITATION(S) 24026, 25006, 25117, 25688

25119 (ARH-SA—266) **Ion exchange purification of bis(2-ethylhexyl)phosphoric acid.** Honaker, C.B.; Schulz, W.W. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Aug 1976. Contract E(45-1)-2130. 12p. (CONF-761002—5). Dep. NTIS $3.50.

From 28. southeastern regional meeting of American Chemical Society on biological applications of liquid chromatography; Gatlinburg, Tennessee, United States of America (USA) (27 Oct 1976).

Bis(2-ethylhexyl)phosphoric acid (HDEHP) may be purified by absorption on a macroreticular, strong base anion exchange resin. Properties of ion exchange purified HDEHP are in excellent agreement with literature values.

25120 (LA-UR—76-2127) **LASL medical radioisotope research program: radiochemistry problems and new developments.** O'Brian, H.A. Jr.; Grant, P.M.; Ogard, A.E. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 11p. (CONF-760371—2). Dep. NTIS $3.50.

From 4. cyclotron users' meeting; Miami, Florida, United States of America (USA) (25 Mar 1976).

A brief summary is given of the more recent development in the measurements of cross sections and yields in nucleon bombardments, radiochemical separation studies, and radionuclide generator developments. Radiochemical separations were described for ^{43}K, ^{77}Br, ^{82}Sr, ^{123}I, ^{127}Xe, and ^{172}Hf. Cross sections were measured at 590 and 800 MeV for proton spallation reactions on V yielding K isotopes, Mo yielding Sr isotopes, and La yielding I and Xe isotopes. Measurements were made at 800 MeV on Ni yielding Fe isotopes and Ar yielding Cu and Ga isotopes. Measurements were made at 590 MeV on Ta yielding Hf isotopes. (JSR)

25121 (LA-tr—76-36) **Extraction and chromatographic methods for isolation of uranium for analytical purposes.** Krtil, J. Translated from *Jad. Energ.;* **21**: 421-425(1975). 17p. Dep. NTIS $3.50.

Methods of separation which are used for uranium separation mainly from irradiated fuels are reviewed. We call attention mostly to selective and rapid methods based on extraction and ion exchange which seem to be most promising for isolation of uranium from irradiated nuclear materials. 79 references.

25122 **Organic acid solutions in the chromatography of inorganics ions. IV. Cation-exchange of Mn(II), Cd(II), Co(II), Ni(II), Cu(II), Al(III), and Fe(III) in tartrate media.** Dadone, A.; Baffi, F.; Frache, R. (Univ. of Genoa). *Talanta;* **23**: 593-595(7 Nov 1975).

Macroporous arsonic acid resins with different pore sizes and surface areas were prepared and the properties compared. One of the resins was used for concentration of trace metal ions from dimineralized water, tap-water, and seawater. The effect of pH and complexing agents on the recovery of metal ions was studied. A method for separation of uranium(VI) and thorium(IV) from each other and from other metal ions was developed.

25123 **Universal detector for liquid chromatography based upon dielectric constant.** Klatt, L.N. (Oak Ridge National Lab., TN). *Anal. Chem.;* **48**: No. 13, 1845-1850(Nov 1976).

A liquid chromatography detector based upon dielectric constant is described. The detector employs a modular phase-locked-loop circuit with its operating frequency determined by the dielectric constant of the column effluent. Readout is the shift in frequency resulting from changes in solution dielectric constant as a solute band elutes from the column. Response is independent of intrinsic solvent conductivity and dielectric losses associated with dipole—dipole relaxation. The detector has excellent stability and reproducibility, negligible sensitivity to variations in solvent flow rate, and the capability of operating without any restrictions on solvent dielectric constant. Separations employing low and high dielectric constant eluants were monitored. An average detection limit of 0.0005 $\Delta\epsilon$ was measured in low dielectric constant media. Comparison with the uv and refractive index monitors indicates that the dielectric constant detector should find numerous applications in liquid chromatography.

25124 **Diffusion sampling method for ambient aerosol size discrimination with chemical composition determination.** Marlow, W.H.; Tanner, R.L. (Brookhaven National Lab., Upton, NY). *Anal. Chem.;* **48**: No. 13, 1999-2001(Nov 1976).

A method for sampling aerosols is described by which particles below the optical scattering range (< 0.3 μm diameter) can be separated into size-related categories by diffusion, and variations in the chemical composition of sulfur compounds in these particles as a function of size can be identified by filter collection and subsequent analysis. Application of a battery of diffusion cells of appropriate length allows sampling of ambient aerosols for the purpose of chemical speciation of airborne sulfate as a function of particle size with time discrimination of 1 to 2 h. Representative data illustrating the diffusion sampling method are discussed. Precision and accuracy of the chemical methods for sulfate speciation are +-15% at ambient concentrations and the limit of detection of sulfate and strong acid are, respectively, 2 μg and 0.1 μequiv.

INORGANIC AND PHYSICAL CHEMISTRY

REFER ALSO TO CITATION(S) 25008

25125 (COO—2810-2) **Formation and study of exciplex systems: a low-pressure approach. Quarterly progress report No. 1, December 1, 1975—February 29, 1976.** Sanzone, G. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Dept. of Chemistry). 1976. Contract E(11-1)-2810. 16p. Dep. NTIS $3.50.

The experimental system proposed for the formation of excimers from their van der Waals ground states is based on the production of a high steady-state concentration of the dimers or oligomers by free-jet expansion. These will be excited by low-energy resonant electron bombardment to yield excimers or exciplexes in an excited vibrational state. The evolution of the design criteria for this system is described. (JSR)

25126 **Magnetic properties of $[(CH_3)_3NH]CoCl_3\ 2H_2O$ and its deuterium analogue.** Bhatia, S.N.; O'Connor, C.J.; Carlin, R.L. (Univ. of Illinois, Chicago). *Inorg. Chem.;* **15**: No. 11, 2900-2904(Nov 1976).

Measurements are reported of the specific heat and single-crystal principal susceptibilities in the helium region of $[(CH_3)_3ND]CoCl_3\ .\ 2D_2O$ and compared with those of protonic material. The effect of deuteration on the magnetic ordering temperature as well as on the exchange parameters is negligible. Because of the weak ferromagnetism of this material, sample size and shape affect the accuracy of magnetic measurements, causing a larger effect on the results than does the replacement of hydrogen by deuterium.

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 23895, 23940, 24154, 25142, 25288, 25318

25127 (BNL—21373) **Probabilistic approach to the turbulent mixing of reactive scalars.** Dopazo, C. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract E(30-1)-16. 5p. (CONF-761003—16). Dep. NTIS $3.50.

From Symposium on atmospheric turbulence, diffusion, and air quality; Raleigh, North Carolina, United States of America (USA) (19 Oct 1976).

A formal closure of the first order probability density function equation is presented. After numerous assumptions, not always justified, the K diffusivity model can be recovered and is seen to be associated with the Gaussianity of a differential operator. Higher order corrections to the K-model can be systematically included. Some laboratory measurements are described to justify some of the closure assumptions that have been or could be used.

25128 (FE—2408-1) **Study of the mechanism of the hydrogen sulfide/dolomite reaction. Quarterly report, July—September 1976.** Li, K. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA)). Oct 1976. Contract EX-76-S-01-2408. 12p. Dep. NTIS $3.50.

A thermogravimetric analysis system is central to this work. The present design was evolved after a thorough and careful study of the high-pressure TGA system designs reported in the literature. There are two components in the design: a reactor and a gas feed system. The reactor consists of a high-pressure enclosure of stainless steel to house the balance mechanism from a DuPont 951 TGA and an externally heated vertical reactor tube. The main advantage of this design is the spatial separation of the balance mechanism from the reaction zone, thus providing protection of the balance mechanism from thermal and chemical attack. Practically nonexistent information on corrosion of metals by hydrogen sulfide at high temperatures and high pressures has led to a design of the reactor convections which allow easy removal and replacement of reactor tubes. The danger of overexposure to corrosive gases will be lessened by periodic replacement of reactor tubes. Use of interchangeable tubes of different materials will permit evaluation of material strength and corrosion resistance to corrosive gases at conditions comparable to those in coal gasification. Construction of the reactor system is 50% completed, and of the gas feed system, 80% completed.

25129 (ORNL—5231) **Statistical modelling of adsorption processes on catalyst surfaces: preliminary report.** Fuller, E.L. Jr.; Ebey, S.; Uppuluri, V.R.R. (Oak Ridge National Lab., Tenn. (USA)). Dec 1976. Contract W-7405-ENG-26. 111p. Dep. NTIS $5.50.

A three-faceted approach was fruitful in modelling surface reactions involved in heterogeneous catalysis. The chemisorption reactions have been modelled as immobile binding, involving adjacent sites on the solid surfaces, forming the "activated intermediate" which is the key step in most intrafacial or suprafacial catalytic processes. The kinetics and stoichiometry of these processes was analyzed by a detailed comparison of experimental data, computer simulation, and mathematical analyses. Several unexplained experimental results are satisfactorily interpreted in terms of these models on a semi-quantitative basis. Previously, qualitative explanations had been proposed which embodied much of the logic of our models. The results are adequately developed to determine, by inference, the lattice structure of the surfaces in terms of the kinetics and stoichiometry of the adsorption processes. The results of this preliminary study indicate that additional analyses will be beneficial in interpreting surface reactions of interest in the field of heterogeneous catalysis. The results have been very successful in giving a phenomenological model where the restructuring process involves suprafacial desorption-readsorption to achieve the complete ideal monolayer. Data show that this process depends on the nature of the adjacent fluid phase. The process is virtually impossible for gas phase contact whereas it is slow and first order through the more structured liquid phase.

25130 (RFP-Trans—216) **Secondary-valence cyclic compounds. IV. On some internally complexed cobalt salts of hydroxyaldehydediimines.** Tsumaki, T. Translated from *Bull. Chem. Soc. Jpn.;* **13**: No. 2, 252-260(1938). 7p. Dep. NTIS $3.50.

The synthesis, crystallization, and oxidation of salicylaldehyde-ethylenediimine-cobalt, its chloroform and oxygen addition compounds, and its hydroxide and chloride are described. (JSR)

25131 **Electron attachment to molecules in dense gases (quasi-liquids).** Christophorou, L.G. (Oak Ridge National Lab., TN). *Chem. Rev.;* **76**: No. 4, 409-423(Aug 1976).

Current work on electron attachment to molecules in "quasi-liquid" (high-pressure) media is reviewed with expansion and elaboration. The importance of intermediate phase studies in understanding the effects the nature and density of a gaseous medium have on the electron-attachment processes is stressed. Attention is drawn to the experimental evidences showing revelance and unique significance of electron-molecule interaction processes in gases to those in liquid media. 111 references. (BLM)

25132 **High temperature reaction engineering. Special features - subdisciplines - areas of particular interest.** Guenther, R. (Karlsruhe Univ. (TH) (Germany, F.R.). Inst. fuer Feuerungstechnik); Jeschar, R.; Poetke, W. (Technische Univ. Clausthal, Clausthal-Zellerfeld (Germany, F.R.). Inst. fuer Waermetechnik und Industrieofenbau). *Chem.-Ing.-Tech.;* **48**: No. 9, 749-758(Sep 1976). (In German).

From Symposium on high temperature chemical reaction engineering; Harrogate, UK (16 Jun 1975).

17 figs.; 20 refs.

High temperature engineering deals with methods which involve partly chemistry, partly silicates and partly metallurgy. The subject differences are unimportant compared to the common factors such as production of high temperatures mostly by firing, process steps, system construction and materials. The typical methods include the simple heating as well as the physical conversions, such as recrystallization, changes of the stress states, phase transformation and forming or chemical changes, e.g. synthesis and fission, reduction and oxidation, and many others. Certain types of systems are obtained almost independenly of the related material according to the material state - fluid, granular, pieces, large solid -, according to method and temperature. The application of the thermal pipes to fluidized bed furnaces and limestone deacidizing are outlined as typical examples.

25133 **Skeletal molecular structure of monocarbahexaborane from microwave spectral studies.** McKown, G.L. (Univ. of Southern California, Los Angeles); Don, B.P.; Beaudet, R.A.; Vergamini, P.J.; Jones, L.H. *J. Am. Chem. Soc.;* **98**: No. 22, 6909-6912(27 Oct 1976).

The microwave spectra of ten isotopic species of CB_5H_7 have been assigned. The skeletal molecular structure is a distorted octahedron with one face containing three long B—B bonds. There is further evidence that the bridge hydrogen is located above this face. The bond distances are: r(C—B(2)) = 1.60 +- 0.01; r(C—B(5)) = 1.63 +- 0.01; r(B(2)—B(3)) = 1.87 +- 0.01; r(B(2)—B(6)) = 1.89 +- 0.01; r(B(4)—B(5)) = 1.72 +- 0.01; r(B(5)—B(6)) = 1.70 +- 0.01; r(B(2)—B(5)) = 1.70 +- 0.01 A. The dipole moment was measured to be 1.43 +- 0.04 D.

25134 **Direct measurement of spin-state lifetimes in solution for some iron(II) spin equilibrium complexes derived from hexadentate ligands.** Hoselton, M.A. (Univ. of Illinois, Urbana); Drago, R.S.; Wilson, L.J.; Sutin, N. *J. Am. Chem. Soc.;* **98**: No. 22, 6967-6969(27 Oct 1976).

The rates of intersystem crossing of the iron(II) spin equilibrium systems $[Fe(6\text{-}MePy)(Py)_2tren](PF_6)_2$ and $[Fe(6\text{-}MePy)_2(py)tren](PF_6)_2$ have been measured by the laser Raman temperature-jump method. Absorbance changes at the charge-transfer band maximum (λ/sub max/ approximately equals 560 nm) following the temperature-jump perturbation show that the approach to equilibrium occurs by a first-order process. The rate constant for the forward (k_1) and reverse (k/sub -1/) steps in the FeL^{2+} (low spin) reversible FeL^{2+} (high spin) reaction in methanol or aqueous solutions are: L = $(6\text{-}MePy)(Py)_2tren$, $k_1 = 4 \times 10^5$, k/sub -1/ = $8 \times 10^6\ s^{-1}$; L = $(6\text{-}MePy)_2(Py)tren$, $k_1 = 4 \times 10^6$, k/sub -1/ = $5 \times 10^6\ s^{-1}$ at 25°C. The kinetics are discussed and it is shown that the results are consistent with the suggestion that a spin-state equilibrium could precede electron transfer in reductions of the hexaaquocobalt(III) ion.

25135 Structure of solid surfaces. Kesmodel, L.L.; Somorjai, G.A. (Univ. of California, Berkeley). *Acc. Chem. Res.;* **9**: No. 11, 392-398(Nov 1976).

The characterization of the structure of solid surfaces, or surface crystallography, by the technique of low-energy electron diffraction (LEED) is surveyed. After an introduction to essential LEED concepts, the application of electron diffraction to the following types of surfaces is considered: metals, semiconductors, ionic crystals, oxides, and molecular crystals. The emphasis is generally on qualitative considerations. A brief discussion of analysis of stepped surfaces is included. (DDA)

25136 Stable homopolyatomic anions of the post-transition metals. "Zintl ions". The synthesis and structure of a salt containing the heptantimonide(3-) anion. Adolphson, D.G.; Corbett, J.D.; Merryman, D.J. (Ames Lab., IA). *J. Am. Chem. Soc.;* **98**: No. 23, 7234-7239(10 Nov 1976).

The phenomenon of the formation of homopolyatomic or the so-called Zintl anions on solutions of many alloys in liquid ammonia is considered, and a general route to the isolation of stable homopolyatomic anion is illustrated in the case of antimony. The dark brown crystalline (4,7,13,16,21,24-hexaoxa-1, 10-diazabicyclo[8.8.8]hexacasan-) sodium heptantimonide (3-), $(C_{18}H_{36}N_2O_6 \cdot Na^+)_3Sb_7$3p, has been prepared from the reaction of a sodium—antimony alloy with $C_{18}H_{36}N_2O_6$(2,2,2-crypt) in ethylenediamine. Lattice constants a = 23.292 A, b = 13.791 A, c = 25.355 A, and β = 108.56° with four molecules per unit cell in space group $P2_1/n$ were deduced from three-dimensional x-ray data collected from a single crystal of the compound on a four-circle diffractometer using MoK/sub α/ radiation. The problem was phased using direct methods. Stepwise full-matrix least-squares refinement of the ten heavy atoms with anisotropic thermal parameters and of the 78 light atoms of the crypts with isotropic temperature factors resulted in converged atomic parameter with R = 0.111 and R/sub w/ = 0.134. Three cryptated sodium cations in which the sodium ion occupies the central cavity of the macrobicycle occur together with the $Sb_7$3p cluster anion, the first example of a well-characterized polyatomic anion for a metallic element. The polyantimony anion exhibits approximate C/sub 3v/ symmetry as an end-capped trigonal prism with the capped face substantially expandable, analogous to the isoelectric P_4S_3. Bond distances in the cluster range from 2.693 to 2.880 A. Possible geometries for several other Zintl ions of the group 5 elements are proposed on the basis of known isoelectric ions or molecules.

25137 Charge-transfer complexes. NH_3—O_3, NH_3—SO_2, and $N(CH_3)_3$—SO_2. Lucchese, R.R.; Haber, K.; Schaefer, H.F. III. (Univ. of California, Berkeley). *J. Am. Chem. Soc.;* **98**: No. 24, 7617-7620(24 Nov 1976).

The donor—acceptor complex between trimethylamine and sulfur dioxide is the strongest (in terms of its dissociation energy to $N(CH_3)_3$ plus SO_2) such complex yet to be studied experimentally in the gas phase. Ab initio self-consistent-field theory has been applied to this and two related complexes, NH_3O_3 and NH_3SO_2. Minimum basis sets were used for all three complexes, while for NH_3SO_2 two considerably larger sets (double zeta and double zeta plus sulfur d functions) were employed. The equilibrium structure of these complexes was predicted by an investigation of many points on the respective potential energy surface. To a surprising degree, the O_3 or SO_2 molecule is found to lie in a plane nearly perpendicular to ttthe amine C/sub 3v/ axis. Further, the central atom in O_3 and SO_2 is predicted to lie only slighty off the amine C/sub 3v/ axis. With these guidelines, the prediction of further structures of this type essentially reduces a one-dimensional search for the central atom-N distance. Using a minimum basis set, the three predicted binding energies at 2.24, 5.00, and 4.06 kcal/mole. Using the double zeta basis set the NH_3—SO_2 dissociation energy is increased to 10.40 kcal/mole. When a set of sulfur d functions is added to the latter set, the binding energy becomes 9.30 kcal/mole in the absence of geometry reoptimization.

25138 Extensive redistribution of fluorine and hydrogen in the reaction of CF_3i with SiH_4. Krause, J.R.; Lampe, F.W. (Pennsylvania State Univ., University Park). *J. Am. Chem. Soc.;* **98**: No. 24, 7826-7827(24 Nov 1976).

CF_3i ions were formed from either CF_4 or CF_3Cl in an electron-impact ion-source, separated from other ions, that were simultaneously produced, by a quadrupole mass filter, and injected at barycentric energies of 0.3 to 10 eV into a collision cell containing SiH_4. The ions produced by the collision were mass analyzed then detected by an electron multiplier. Reaction mechanisms were discussed; but the surprising feature of the reaction was considered to be that at low kinetic energies ions such as CH_3i, CH_3F^+, and $SiHF_2i$, which represent extensive redistribution of H and F atoms, were formed.

25139 Novel partially oxidized distorted one-dimensional platinum chain in $K_{1.6}Pt(C_2O_4)_2.1.2H_2O$. Reis, A.H. Jr.; Peterson, S.W.; Lin, S.C. (Argonne National Lab., IL). *J. Am. Chem. Soc.;* **98**: No. 24, 7839-7840(24 Nov 1976).

Single-crystal x-ray diffraction data were used to determine the molecular and crystal structure of $K_{1.6}Pt(C_2O_4)_2 \cdot 1.2\ H_2O$. Cell dimensions and structural properties of the triclinic crystals were discussed, and schematic models were presented. A comparison was made between the partially oxidized potassium bisoxalate complex and $K_{1.75}Pt(CN)_4 \cdot 1.5\ H_2O$. (DDA)

25140 Thermodynamic properties of dilute sulfuric acid and the potential of the lead sulfate—lead electrode. Pitzer, K.S. (Univ. of California, Berkeley). *J. Phys. Chem.;* **80**: No. 26, 2863-2864(16 Dec 1976).

The 1934 data of Shrawder and Cowperthwaite for the cell Pt, H_2 Vertical bar H_2SO_4(m) Vertical bar $PbSO_4$, Pb, Hg, which have been generally ignored, are shown to yield valuable information about the properties of sulfuric acid in the range below 0.02 M and to give probably the best available value for the potential of the lead-lead sulfate electrode.

ISOTOPE EFFECTS

REFER ALSO TO CITATION(S) 25126

ORGANIC CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 23945, 25130, 25137, 25157, 25288, 25320, 25321, 25322, 25323

25141 (COO—2026-32) Studies in chemical reactivity. Progress report, January 1, 1976—December 31, 1976. Carr, R.W. Jr. (Minnesota Univ., Minneapolis (USA). Dept. of Chemical Engineering and Materials Science). Dec 1976. Contract EY-76-S-02-2026. 12p. Dep. NTIS $3.50.

Collisional deactivation of chemically activated ethylcyclobutane, formed at about 100 kcal/mole, was found to occur by a multistep process with methylcyclobutane and cyclohexane as the principal collision partners. A stepladder model with step sizes of 4 kcal/mole gives an adequate description of the deactivation process. Evidence for multistep deactivation of chemically activated methylcyclopropane has also been obtained. Working equations for the calculation of the average energy of chemically activated species were derived, and the effects of various assumptions about the energy distribution function of chemically activated species were computationally tested. A mathematical model for diffusion and reaction (with hydroxyl radicals) of $CHFCl_2$ and CHF_2Cl in the atmosphere, up to 60 km, was developed. It was found that 99 to 97 percent of the $CHFCl_2$ and 96 to 88 percent of the CHF_2Cl react to form chlorofluoromethyl radicals in the troposphere. The fate of these radicals is currently being investigated. Research is continuing on (1) photochemical smog mechanisms, (2) flash photolysis with time-resolved mass spectrometry and (3) the $CH_2(^1B_1)$ yields CH_2 ($^1A_1$) emission spectrum.

25142 (LBL—5375) Resonance Raman spectroscopy of manganese (III) etioporphyrin I, chromium (III) tetraphenylporphin and hemoglobin: the dependence of resonance enhancement on the resonant electronic transition. Asher, S.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1976. Contract W-7405-ENG-48. 203p. Dep. NTIS $7.75.

Thesis.

Resonance Raman spectroscopy (RRS) and magnetic circular dichroism are used to study the electronic transitions of Mn (III) etioporphyrin I (MnETP). The data supports the assignment of the strong band of Mn (III) porphyrins between 460 and 490 nm to a charge transfer transition. The two bands occurring between 540 and 600 nm are assigned to vibronic components of a π yields π^* transition. The band in the near uv appears to contain a number of components. It is suggested that this band has both π yields π^* and charge transfer character. Dramatic differences are found in the RR spectra of MnETP upon excitation within different absorption bands. The RR spectra of MnETP - X (X = F^-, Cl^-, Br^-, I^-, or butanol) excited in the charge transfer band show large differences in the low frequency region (100 to 500 cm^{-1}), depending on the axial ligand. Pure Mn-halide vibrations are assigned. An explanation is proposed to account for the differences between the RR spectra excited in the Q bands and the charge transfer band. Some of the vibrational Raman bands in the low frequency region may serve as probes for the degree of out-of-plane distortion of the metal from the porphyrin plane. The resonance Raman spectra of Cr (III) tetraphenylporphin (CrTPP) indicate that the three absorption bands of CrTPP occurring between 420 and 600 nm result from π yields π^* transitions. The resonance Raman spectra of F^-, N^-a and OH^- complexes of methemoglobin are studied by excitation in the charge transfer bands, which occur between 590 and 650 nm. A selective enhancement of vibrations of the axial ligand against the iron is observed. The addition of inositol hexaphosphate results in no changes in the

resonance Raman spectra. The lack of a shift in the energy of the Fe—F^- vibration is interpreted to indicate that there is no movement of the iron relative to the porphyrin plane.

25143 (LBL—5392) **Sterol molecule: its analysis and utility as a chemotaxonomic marker and a fine geochemical probe into earth's past.** Toste, A.P. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1976. Contract W-7405-ENG-48. 465p. Dep. NTIS $12.00.

Thesis.

Geochemical and bacteriological investigations, using Mono Lake, California, as a geochemical model, reveal that the sterol molecule is suited as: (1) a chemotaxonomic marker for classifying bacteria; and (2) a geochemical probe into Earth's past, capable of unraveling its biological history and the mechanism of organic diagenesis in sediments. Analysis of the sterol content of a stratigraphic sequence of recent sediments indicates that: (1) dramatic fluctuations in the lake's biota have occurred, both with respect to biological productivity and the types of organisms present; and (2) extensive non-dispersive sterol diagenesis, specifically stanol genesis, has occurred in Mono Lake's sedimentary record. On the basis of the stratigraphic studies, it appears that C_{27}-stanol genesis has been much more vigorous than both C_{28}- and C_{29}-stanol genesis, with the latter being the least vigorous. Most of the sediments' stanols exist as 5α-stanols, suggesting that there has been a general preference for 5α-stanol genesis. There is also evidence for 5β-stanol genesis as well. A variety of bacteria thrive in Mono Lake's surface muds, and not only contribute source stenols to the muds' sterol pools but also mediate dispersive and nondispersive sterol diagenesis, both aerobically and anaerobically. These findings, combined with those of other investigations, suggest a mechanism for non-dispersive sterol diagenesis. The model is composed of three distinct pathways whose driving force consists of a complementary mediation of biological and geological forces. One route begins with long-term sterene genesis via geothermal processing. The other two begin with stanol genesis, but one entails rapid, stereospecific bacterial reduction, whereas the other involves long-term, non-specific geological reduction via heat/pressure catalysis. (JGB)

25144 Electronic spectroscopy of highly polar aromatics. XI. Luminescence of the cyanoanilines. Lui, Y.H.; McGlynn, S.P. (Louisiana State Univ., Baton Rouge). *J. Lumin.;* **10**: No. 2, 113-121(Mar 1975).

The absorption and emission spectra of the three isomeric cyanoanilines have been investigated. Quantum yields and decay lifetimes are reported for both fluorescence and phosphorescence processes. It is shown that the lowest energy absorption band of p-cyanoaniline of two distinct electronic transitions of the $^1t^*$ reverse arrow ^1t type, whereas, in the o- and m-cyanoanilines, the lowest energy absorption band consists of a single electronic transition of the $^1t^*$ reverse arrow ^1t type. These conditions are consistent with absorption data, emission data and kinetic analyses. The largest Phi/sub P//Phi/sub F/ ratio is exhibited by the p-cyanoaniline and this observation is rationalized.

25145 Semi-empirical calculations of π-electron affinities for some conjugated organic molecules. Younkin, J.M.; Smith, L.J.; Compton, R.N. (Oak Ridge National Lab., TN). *Theor. Chim. Acta;* **41**: 157-176(1976).

Energy levels have been calculated for some conjugated systems containing C, N, and O atoms using a semi-empirical method based upon a variable β-γ modification of the Pariser-Parr-Pople approximation to the Hartree-Fock equation. Koopmans' theorem is used to relate the calculated energy of the lowest vacant molecular orbital, epsilon/sub LVMO/, to the adiabatic electron affinity of a molecule. The approach is identical to that used previously by Kunii and Kuroda. An excellent correlation is found between electron affinities deduced from recent beam experiments and epsilon/sub LVMO/. This relationship is used to predict electron affinities for over 100 other organic molecules. In addition, excited state energies for negative ions are calculated, and good agreement is found with the available experimental data. Bound excited states are also predicted for some organics which contain the $=C(CN)_2$ substructure. The additive contribution of group substitutions to the electron affinity is discussed for the case of CN substitutions to ethylene, benzene, and naphthalene.

25146 Photoelectron spectra of carbonyls, carbonates, oxalates, and esterification effects. McGlynn, S.P. (Louisiana State Univ., Baton Rouge); Meeks, J.L. *J. Electron Spectrosc. Relat. Phenom.;* **8**: 85-93(1976).

Photoelectron spectra are reported for dimethyl carbonate, ethylene carbonate, oxalic acid, dimethyl oxalate and diethyl oxalate. These spectra are discussed on a composite molecule basis using computational data and many of the individual bands are identified. The differential effects of esterification on ionization energies are discussed briefly.

25147 Electronic spectroscopy of highly-polar aromatics. XIII. Absorption and luminescence of nitroanilines. Khalil, O.S.; McGlynn, S.P. (Louisiana State Univ., Baton Rouge). *J. Lumin.;* **11**: No. 3-4, 185-196(1976).

The absorption spectra of the nitroanilines have been reexamined. The experimental data favor those models which predict that the lowest-energy absorption band of the p-derivative encompasses two or more electronic transitions whereas that of either the o- or m-derivative encompasses only one electronic transition. The unique luminescence characteristics of these molecules are discussed.

25148 Synthesis and structure of dicarbonyldi-eta-cyclopentadienylbis(μ-thiocarbonyl)diiron, a thiocarbonyl analog of the dicarbonyl-eta-cyclopentadienyliron dimer. Dunker, J.W.; Finer, J.S.; Clardy, J.; Angelici, R.J. (Ames Lab., IA). *J. Organomet. Chem.;* **114**: C49-C52(1976).

Sodium hydride reduction of (eta-C_5H_5)$Fe(CO)_2(CS)^+$ gives cis- and trans-[(eta-C_5H_5)$Fe(CS)(CO)]_2$. The trans isomer slowly converts to a cis-trans mixture in xylene solution. An X-ray structural study of the cis isomer shows the CS groups to be in the bridging positions, but otherwise, its structure is nearly identical to that of cis-[(eta-C_5H_5)$Fe(CO)_2]_2$. The cis isomer reacts with CH_3OSO_2F to give the compound, (eta-C_5H_5)$_2Fe_2(CSCH_3)(CS)(CO)_2$i, with a methylated bridging thiocarbonyl group.

25149 Hydrogen bonding study of quinoline and coal-derived asphaltene components with o-phenylphenol by proton magnetic resonance. Taylor, S.C.; Galya, L.G.; Brown, B.J.; Li, N.C. (Duquesne Univ., Pittsburgh). *Spectrosc. Lett.;* **9**: No. 11, 733-741(1976).

Proton magnetic resonance (PMR) studies are reported of hydrogen bonding between the OH proton of o-phenylphenol (OPP) and the nitrogen electron donor of quinoline (Qu). Data are also reported on the hydrogen bonding of a coal-derived asphaltene and its acid and base components with OPP. Determination was made of the equilibrium constants of the 1:1 complex between OPP and Qu at 39, 32, 1, and -18°C from the PMR studies. Qualitative results are reported for the interaction between the base fraction of asphaltene and OPP at 32, 1, and -26°C.

25150 Molecular structure of acrolein electronic states. Dykstra, C.E. (Univ. of California, Berkeley). *J. Am. Chem. Soc.;* **98**: No. 23, 7182-7187(10 Nov 1976).

The ground and low-lying singlet and triplet states of acrolein, CH_2CHCHO, have been studied with ab initio SCF methods using a double zeta basis set of Gaussian orbitals. The cis and trans ground-state geometries were optimized and vertical excitation energies were determined for n yields π^* and π yields π^* singlet and triplet states. The separation between the cis and trans ground states was found to be 540 cm^{-1}. Optimization of major bond lengths placed the π yields π^* states very close energetically to the n yields π^* states. For all excited states, the carbon—oxygen bond length was substantially longer than in the ground state. For the π yields π^* singlet and triplet, the single/double bond character of the carbon—carbon bonds is interchanged with respect to the ground state. The ground and lowest excited singlet and triplet states are planar.

25151 Electron exchange and electron transfer of semiquinones in aqueous solutions. Meisel, D.; Fessenden, R.W. (Carnegie—Mellon Univ., Pittsburgh). *J. Am. Chem. Soc.;* **98**: No. 24, 7505-7510(24 Nov 1976).

Rate constants for self-exchange of electrons between semiquinone radical ions and their parent quinones were measured for four benzoquinone derivatives in aqueous solutions (containing 5 M 2-propanol and 1 M acetone at pH 7). This was accomplished by measuring the effect of the concentration of the quinone on the ESR line width of the semiquinone radical ion produced by in situ photolysis. The quinones studied were benzoquinone, 2,5- and 2,6-dimethylbenzoquinone, and duroquinone. The rate constants for the electron exchange for these couples were found to be in the range of 0.5 to 2 x 10^9 $M^{-1}s^{-1}$. Electron transfer from one semiquinone to another quinone in this group of benzoquinone derivatives was measured using kinetic spectrophotometry and pulse radiolysis. Since one-electron reduction potentials for all of these quinone/semiquinone couples are known from pulse radiolysis determination of the equilibria, electron transfer rates can be predicted using the Marcus theory from rates of the self-exchange reactions. The calculated rates thus obtained are in good agreement with the experimentally measured rate constants. Reaction radii could be estimated and further correlations between the rates of electron transfer and the free energy changes were checked.

25152 Transmission of substituent effects. Generalization of the ellipsoidal cavity field effect model. Ehrenson, S. (Brookhaven National Lab., Upton, NY). *J. Am. Chem. Soc.;* **98**: No. 24, 7510-7514(24 Nov 1976).

The ellipsoidal cavity field effect model of Westheimer and Kirkwood for transmission of polar substituent effects is extended to remove the constraint of interacting site-focus coincidence. This allows more rational specification of the geometry of the cavity, and hence of the effective dielectric, based upon physically realistic

intermolecular (solute-solvent) distances. Significant improvements in the power of the model are noted upon application to several experimentally studied systems, both in terms of the quality of relative reactivity predictions and in internal self-consistency.

25153 Theoretical study of the protonation of glycine in gas-phase ion—molecule reactions. Chung, K.; Hedges, R.M; Macfarlane, R.D. (Texas A and M Univ., College Station). *J. Am. Chem. Soc.;* **98**: No. 24, 7523-7525(24 Nov 1976).

The electronic structure of glycine and its ion-molecule association reaction with H^+ have been studied using a semi-empirical INDO-type molecular orbital computation. The results indicate that the association reaction of glycine with H^+ produces a quasi-molecular ion possessing two functional groups, NH_2 and COOH, interacting through N—HO type hydrogen bonding. However, a wide range of conformations is suggested due to the low energy barriers among the several different configurations.

25154 Arrival time distributions in high pressure mass spectrometry. V. Effect of E/P on measured apparent heats and entropies of reaction. Meisels, G.G.; Mitchum, R.K.; Freeman, J.P. (Univ. of Nebraska, Lincoln). *J. Phys. Chem.;* **80**: No. 26, 2845-2848(16 Dec 1976).

The temperature dependence of the equilibrium involving the proton transfer between methane and carbon dioxide and their protonated analogues has been investigated at a series of values of the field strength E/P. The apparent values of ΔS and ΔH were found to depend on E/P; experimental uncertainty in the former was too large to establish systematic trends. The latter decreased approximately linearly with E/P; limiting values of $\Delta H = -1.58 \pm 0.06$ kcal/mole and $\Delta S = 1.7 \pm 0.3$ eu are in good agreement with those obtained by flowing afterglow and ICR techniques.

ISOTOPE EFFECTS

REFER ALSO TO CITATION(S) 25118

25155 (COO—3127-16) Studies of carbon-13 vapor pressure isotope effect in CHF_3. Borodinsky, L.; Ishida, T. (City Univ. of New York, N.Y. (USA)). Aug 1976. Contract E(11-1)-3127. 151p. Dep. NTIS $6.75.

Thesis.

The vapor pressure of $^{13}CHF_3$ relative to $^{12}CHF_3$ has been measured from 161 to 205°K using a modified Bigeleisen distillation column and chromatography and mass spectroscopy of the oxidized samples. The data of each distillation run were reduced in light of a modified Cohen's theory of the kinetics of a square cascade of close-separation stages. The vapor pressure isotope effect for carbon substitution in CHF_3 in this temperature range was found to be an inverse effect. A trend of increasing inverse effect. A trend of increasing inverse effect with decreasing temperature has been observed. The relative vapor pressure may be expressed as $\ln P'/P = (217 \pm 66)/T - (0.89 \pm 0.36)/T$, where P' and P are the vapor pressures of $^{12}CHF_3$ and $^{13}CHF_3$ respectively. A cell model liquid force field for trifluoromethane is derived and the F matrix elements fit to the observed vapor pressure isotope effect are tabulated. 37 tables, 32 fig. (DLC)

25156 ESR and ENDOR studies of the π cation radical of bacteriochlorophyll. Borg, D.C.; Forman, A.; Fajer, J. (Brookhaven National Lab., Upton, NY). *J. Am. Chem. Soc.;* **98**: No. 22, 6889-6896(27 Oct 1976).

Chemical oxidation of bacteriochlorophyll (BChl) in nonaqueous solvents, under rigorously anaerobic and anhydrous conditions, yields a stable cation radical ($BChl^+$). This species, investigated by computer-assisted magnetic resonance techniques, displays, at 0°C, partially resolved ESR spectra and reveals, through high power ENDOR at least seven proton hyperfine splittings. The latter are assigned on the basis of reported molecular orbital calculations, selective deuterations, and model compound studies, and the assignments are supported by reconstruction of the experimental ESR spectra of both protonated and deuterated $BChl^+$. Predictions based on these same assignments for the overall line widths of the Gaussian singlet ESR spectra to be expected for both protonated and deuterated $P870^+$ (the oxidized form of BChl in vivo) are also in good agreement with reported experimental values. Hence the new data provide further support for the dimer model of BChl as the primary electron donor in bacterial photosynthesis and, in addition, help define the electronic configuration of the P870 radical.

25157 Photochemistry in the electronic ground state. IV. Infrared laser induced isomerization of labeled compounds. A possible route for isotope separation. Glatt, I.; Yogev, A. (Weizmann Inst. of Science, Rehovot, Israel). *J. Am. Chem. Soc.;* **98**: No. 22, 7087-7088(27 Oct 1976).

The effects of infrared laser irradiation on the reversible Cope rearrangement of 1,5-hexadiene (biallyl) labelled with deuterium at specific positions was studied. The irradiations were carried out at pressures ranging from 5 to 16 Torr. Higher pressures resulted in a breakdown with acetylene formation. The energy of activation of the shift is 34.3 kcal $mole^{-1}$, and the secondary isotope effect is 10% per atom at room temperature per atom in favor of deuterium in the allylic position. Infrared, NMR, and gas chromatographic studies of the products revealed rearrangement with only minute changes due to volatile cleavage products. this possibility of controlling the direction of isomerization reaction can be applied to isotope separation purposes by choosing a nondegenerate chemical system, so that the selectively enriched component might be separated either by chemical or physical methods. (BLM)

ELECTROCHEMISTRY

REFER ALSO TO CITATION(S) 25140

25158 Mass transfer of a rotating disk in transition flow. Mohr, C.M. Jr.; Newman, J. (Univ. of California, Berkeley). *J. Electrochem. Soc.;* **123**: No. 11, 1687-1691(Nov 1976).

An experimental study of mass transfer to a rotating disk electrode was employed to determine an empirical correlation for the mass transfer rate in the Reynolds number regime lying between simple laminar and turbulent flows. This domain, apparently characterized by a regular vortex pattern, was found to extend from a Reynolds number of 2.0×10^5 to approximately 3.0×10^5. The resultant correlation for the average transfer rate, in terms of dimensionless Nusselt, Reynolds, and Schmidt numbers, is $Nu = 0.89 \times 10^5$ Re$_0$ ⁻/sup ¹/₂/Sc/sup ¹/₃/ + 9.7×10^{-15} Re$_0$3 Sc/sup¹/₃/. The result is strictly applicable to the case of a uniform surface concentration; that is, to the limiting-current condition. (6 figures)

PHOTOCHEMISTRY

REFER ALSO TO CITATION(S) 23955, 25157

25159 Dye laser-induced photodissociation of C_7H_8i ions in gaseous toluene. Eyler, J.R. (Univ. of Florida, Gainesville). *J. Am. Chem. Soc.;* **98**: No. 22, 6831-6834(27 Oct 1976).

The photodissociation process $C_7H_8i + h\nu$ yields $C_7H_7i + H$ has been studied in the wavelength region 540 to 490 nm using a flashlamp-pumped organic dye laser with a pulsed ion cyclotron resonance analyzer cell located inside the laser cavity. A smoothly rising curve with an apparent onset at 538 +- 2 nm (2.31 +- 0.01 eV) and no significant fine structure has been observed. The onset and general shape of the observed curve agree quite well with an earlier study. By comparison with the photodetachment of SH^- ($SH^- + h\nu$ yields $SH. + e^-$), a value of $\sigma(490) = 1.01 \pm 0.24 \times 10^{-18}$ cm² has been obtained for the absolute cross-section for C_7H_8i photodissociation at 490 nm.

25160 Electron spin resonance study of liquids during photolysis. XXI. Dipeptides. Doherty, D.G.; Livingston, R.; Zeldes, H. (Oak Ridge National Lab., TN). *J. Am. Chem. Soc.;* **98**: No. 24, 7717-7723(24 Nov 1976).

Aqueous solutions of dipeptides containing about 1% hydrogen peroxide have been photolyzed at room temperature and the resulting radicals studied by electron spin resonance. The peroxide gives OH which abstracts hydrogen from the peptide. Radicals are formed from L-prolyglycine and β-alanyl-L-proline by abstraction of hydrogen from the carbon located between the peptide nitrogen and carboxylate group. In the latter case the spectrum is affected by the presence of cis-trans isomers and dynamic phenomena. In both β-alanyl-L-valine and glycyl-L-valine the abstraction is almost entirely from the isopropyl side chain giving a mixture of radicals corresponding to loss of one or the other kind of hydrogen in the isopropyl group. Hydrogen is abstracted from the methyl group of β-alanylsarcosine to give a mixture of cis and trans forms of the radical. Glycyl-L-aspartate and β-alanyl-L-aspartate each give a mixture of two radicals. One of these is a direct result of hydrogen abstraction from the side chain while the other involves chemical modification of the side chain. Hyperfine couplings and g values have been measured and are discussed.

25161 Hydrogen-atom initiated decomposition of monosilane. Austin, E.R.; Lampe, F.W. (Pennsylvania State Univ., University Park). *J. Phys. Chem.;* **80**: No. 26, 2811-2817(16 Dec 1976).

The H-atom initiated decomposition of SiH_4 at room temperature produces mainly H_2, Si_2H_6, and a solid deposit with trace amounts of Si_3H_8 and Si_4H_{10} appearing later as secondary products. The initial reaction appears to be nearly completely described by a gas-phase conversion of SiH_4 to Si_2H_6 and H_2 but the secondary gas-phase reactions are strongly influenced by surface reactions involving silicon hydride polymer. Detailed studies of the H—D distribution in the disilane product of an equimolar mixture of SiH_4 and SiD_4 show conclusively that the disilane is formed by insertion reactions

of SiH_3, SiHD, and SiD_2 radicals into SiH_4 and SiD_4 and that combination of SiH_3 and SiD_3 radicals play virtually no role.

RADIATION CHEMISTRY

REFER ALSO TO CITATION(S) 25108

25162 (CONF-760662—3) **Pulse radiolysis of the lanthanide and actinide elements.** Gordon, S.; Sullivan, J.C.; Mulac, W.A.; Cohen, D.; Schmidt, K.H. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 12p. Dep. NTIS $3.50.

From 4. symposium on radiation chemistry; Keszthely, Hungary (1 Jun 1976).

The rate constants for the reaction of e⁻/sub aq/ with all the lanthanides have been examined in greater detail and spectra have been obtained of the resulting product +2 ions for several which have been as yet unreported. Rate constants have been determined for e⁻/sub aq/ with a number of actinides, and spectra of transients and stable species resulting from a number of these reactions have been determined.

25163 (CONF-760662—4) **Piosecond pulse radiolysis studies of hydrated electron reactions.** Matheson, M.S.; Miller, J.R.; Jonah, C.D. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 11p. Dep. NTIS $3.50.

From 4. symposium on radiation chemistry; Keszthely, Hungary (1 Jun 1976).

The reaction of e⁻/sub aq/ with $HgCl_2$, a neutral species, is diffusion-controlled. At high concentrations of solute the rate constant is time-dependent in accord with the Noyes' equation. The hydrated electron reacts with Ag^+ in concentrated solutions of $AgClO_4$ without acquiring an ionic atmosphere, consequently diminishing the effect of ionic strength on the rate constant in pure $AgClO_4$ solutions. Although there is, therefore, presumably a small ionic strength effect for e⁻/sub aq/ + Ag^+ in pure $AgClO_4$ solutions, the rate constant still increases at high concentration (short times), again in accord with theory.

25164 **Pulse radiolysis studies on the OH-induced oxidation of thiolatometal complexes.** Sullivan, J.C.; Deutsch, E.; Adams, G.E.; Gordon, S.; Mulac, W.A.; Schmidt, K.H. (Argonne National Lab., IL). *Inorg. Chem.;* **15**: No. 11, 2864-2868(Nov 1976).

Pulse radiolysis of an N_2O-saturated solution of (mercaptoacetato-O,S) bis (ethylenediamine) chromium(III) perchlorate using the streak-camera method shown two intense transient absorption bands centered at 345 and 410 nm. The absorption bands are due to the oxidation of the compound by OH radicals, the absorption at 345 nm being due to attack at the S atom and the one at 410 nm being due to reaction at the α-carbon atom. The results differ from those obtained by the use of strong chemical one-electron oxidants such as neptunium(VI) and cerium(IV). An explanation is offered for the difference.

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

25165 (TID—26971) **Chemistry of americium.** Schulz, W.W. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 1976. Contract E(45-1)-2130. 300p. Dep. NTIS $6.00.

Essential features of the descriptive chemistry of americium are reviewed. Chapter titles are: discovery, atomic and nuclear properties, collateral reading, production and uses, chemistry in aqueous solution, metal, alloys, and compounds, and, recovery, separation, purification. Author and subject indexes are included. (JCB)

HOT-ATOM CHEMISTRY

25166 **Evidence for the electronic states of recoil carbon atoms undergoing reaction.** Taylor, K.K. (Virginia Polytechnic Inst. and State Univ., Blacksburg); Ache, H.J.; Wolf, A.P. *J. Am. Chem. Soc.;* **98**: No. 23, 7176-7178(10 Nov 1976).

The electronic states of carbon responsible for product formation in systems where the carbon atom is generated by nuclear transformation have been investigated using noble gases in admixture with oxygen-scavenged ethane. Variations in the yields of ethylene—^{11}C, acetylene—^{11}C and carbon—^{11}C monoxide with increasing xenon concentration are explained on the basis of intersystem crossing from ^1D to ^3P carbon. These results are compared to those in helium and neon, where energy degradation is an efficient process, but spin conversion is expected to be unimportant. Acetylene—^{11}C is attributed to reaction by high-energy $C(^3P)$ and low-energy $C(^1D)$, whereas ethylene—^{11}C is formed essentially by high-energy $C(^1D)$. Low-energy $C(^3P)$ is efficiently scavenged by oxygen to form carbon—^{11}C monoxide. Near thermal $C(^3P)$ may also undergo C—H insertion to lead to labeled products as a minor pathway.

PROPERTIES OF RADIOACTIVE MATERIALS

REFER ALSO TO CITATION(S) 24092

25167 (BNWL—2113) **Conversion of tritiated hydrogen to water in the atmosphere.** Burger, L.L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1976. Contract E(45-1)-1830. 47p. Dep. NTIS $4.00.

The report summarizes present information on the atmospheric reactions of tritium. The global distribution of hydrogen and of water is first considered. Data on tritium distribution are then compared and, finally, known reactions which may convert tritiated hydrogen-containing molecules are discussed. Approximately 99 percent of the world's inventory of tritium exists as HTO. Although most of it is in the ocean, a significant portion still resides in the stratosphere. However, in the troposphere, which is the primary concern of this review, most of the tritium is in the form of HT, a smaller amount as HTO, and a much smaller but still significant amount as CH_3T. Further, the tritium-to-hydrogen ratio in the troposphere is higher in hydrogen and in methane than it is in water vapor. The formation of HTO by exchange of HT or T_2 with water or by direct oxidation with oxygen, in the absence of catalysts, is extremely slow at concentrations in the atmosphere that might exist a few minutes after a tritium release. Photochemical oxidation may be the predominant conversion mechanism and over larger periods of time may combine with bacterial action to serve as the principal pathways of conversion of HT (or T_2) and CH_3T to HTO or other more reactive forms of tritium. The net conversion rate following a tritium release to the atmosphere would be expected to be less than 1 percent in 24 hr. The significance of the relatively high tritium content in atmospheric methane needs evaluation. Monitoring of CH_3T has been largely neglected in the past. Considerable uncertainty exists in some of the data on which these conclusions are based and recommendations are made for further work.

25168 (SAND—76-0578) **Room temperature desorption of helium-3 from metal tritides.** Beavis, L.C.; Kass, W.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1976. Contract E(29-1)-789. 30p. Dep. NTIS $4.00.

It has long been known that helium-3 accumulates in metal tritides as tritium decays. Early in life nearly 100% of the helium-3 is retained in the lattice, but when a critical concentration is reached (material dependent), the lattice will no longer retain the helium-3 and it is emitted at about the generation rate. Measurements were recently made on a number of erbium tritides with varying concentrations in the ditritide phase. The expected early release characteristics are observed for all of the samples. However, ditritides with higher tritium concentrations reach the rapid release state at much lower helium-3 concentrations. For instance, the helium to metal concentration for rapid release in the unsaturated ditritide is about 0.22, whereas it is only one-tenth this value in the saturated ditritide. The additional tritium in the tritide appears to be the cause of this effect.

25169 (SAND—76-6246) **Combustion and smoke formation following exposure of actinide metals to explosions.** Luna, R.E.; Church, H.W.; Elrick, R.M.; Parker, D.R.; Nelson, L.S. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1976. Contract E(29-1)-789. 30p. (CONF-761047—1). Dep. NTIS $4.00.

From The Combustion Institute meeting; LaJolla, California, United States of America (USA) (18 Oct 1976).

Results from the plutonium aerosol generation experiment (PAGE) program studies indicate that: (1) Significant quantities of metal-bearing aerosols are likely to be formed in an accidental high explosive detonation of a nuclear weapon. Although the explosive charge-to-metal ratio has been reduced in modern weapons, considerable inhalation hazard is still expected due to increased shrapnel formation and streamer combustion. (2) Close-in shrapnel particle sizes and velocities can be estimated by impact sampling techniques. (3) Uranium droplets are a very accurate simulant of plutonium droplets from the standpoint of combustion-related phenomena but do not seem to simulate either the total quantity of aerosol formed from plutonium droplets or its time-dependent generation pattern very well. This is due primarily to the large effect of the explosion of the burning uranium droplets on total aerosol formation which is not observed in the case of plutonium, even though more aerosol is produced per unit time during the actual combustion itself. (4) The formation of chain-like plutonium aerosols from the droplets produced during streamer combustion is expected to produce an unusually active material from the standpoint of inhalation into the lung and ultimate translocation in the body. 16 figures. (DLC)

25170 **Kinetics of the neptunium(IV)—plutonium(VI) and the neptunium(IV)—neptunium(VI) reactions in aqueous perchlorate solutions.** Newton, T.W.; Montag, T. (Los Alamos Scientific Lab., NM). *Inorg. Chem.;* **15**: No. 11, 2856-2864(Nov 1976).

The oxidation of Np(IV) by Pu(VI) was studied at four temperatures from 30 to 45°C in 1 M (H,Li)ClO_4 solutions with $[H^+]$ between 0.04 and 0.6 M. Calculations were made to allow for

the complications due to further reaction of Pu(V) and other products. The rate law for the predominant reaction is $-d[Np(IV)]/dt = k[Np^{4+}][PuO_2 2i]$, where k depends on $[H^+]$: $k = a[H^+]^{-2} + b[H^+]^{-3}$ or, alternatively, $k^{-1} = (c[H^+]^{-2})^{-1} + (d[H^+]^{-3})^{-1}$. ΔH^* values associated with a,b,c, and d are 31.1 +- 0.9, 40.1 +- 2.0, 33.5 +- 0.8, and 37.3 +- 2.5 kcal/mol, respectively. The corresponding ΔS^* values are 30 +- 3, 53 +- 6, 39 +- 3, and 50 +- 8 cal/(mol deg). Sulfate was found to inhibit the reaction. The oxidation of Np(IV) by Np(VI) was studied at 25 and 35°C in 1 M $(H,Li)ClO_4$ solutions with $[H^+]$ between 0.04 and 0.5 M. Except for the details of the hydrogen ion dependence the results were in agreement with the previous work of Hindman et al.

25171 Kinetics of the oxidation of selenium(IV) by neptunium(VII) in aqueous acidic perchlorate media. Cooper, J.N. (Bucknell Univ., Lewisburg, PA); Woods, M.; Sullivan, J.C.; Deutsch, E. *Inorg. Chem.;* **15**: No. 11, 2862-264(Nov 1976).

The Np(VII) oxidation of Se(IV) proceeds with two-to-one stoichiometry to yield Np(VI) and Se(VI) according to the empirical rate law $-d(\ln[Np(VII)])/dt = k_1[Se(IV)] + k_2[Se(IV)]^2$ with no detectable acid dependence. The apparent activation parameters are $\Delta H_1^* = 7.43$ +- 0.14 and $\Delta H_2^* = 3.70$ +- 0.65 kcal/mol and $\Delta S_1^* = 19.7$ +- 0.5 and $\Delta S_2^* = -28.9$ +- 2.2 eu. This rate law is accounted for by a mechanism involving the known dimerization of Se(IV) in acidic media and parallel paths for the oxidation of both monomeric and dimeric forms. At 25° and $\mu = 1.00$ M, the specific rate constants for oxidation of the monomer (k/sub M/) and dimer (k/sub D/) are (1.07 +- 0.02) x 10^3 and (4.37 +- 0.17) x 10^3 $M^{-1}s^{-1}$, respectvely. The observed rate law and rate parameters are discussed in terms of, and are found to be consistent with, the established reactivity pattern exhibited by Np(VII) when oxidizing aquometal ions.

COMBUSTION CHEMISTRY

REFER ALSO TO CITATION(S) 24306, 25602

ENGINEERING

GENERAL ENGINEERING

25172 (SAND—76-0419) **Maximum-likelihood position estimation.** Lyle, W.D. Jr. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1976. Contract E(29-1)-789. 27p. Dep. NTIS $4.00.

The maximum-likelihood position-estimation equations for single and multipoint estimation of a beacon ranging system are derived. Numerical solutions of the equations are obtained to illustrate the dependence of estimate accuracy on number of beacons, location of beacons, and number of measurements.

25173 (UCRL—52136) **Transferring the technology of welding and bonding: hands-on courses at LLL make it possible.** Jensen, C.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Oct 1976. Contract W-7405-ENG-48. 29p. Dep. NTIS $4.00.

The Technology Training Program approach to the transfer of unclassified technologies from LLL to public use is outlined. A detailed description of the "Welding and Bonding Technology" courses given in the spring of 1976 is presented as well as student and administrative evaluations of the program.

FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 24534, 24554, 24567, 24645, 24841, 24866, 24881, 25008, 25258

25174 (CONF-761110—3) **Fluid-plasticity of thin cylindrical shells.** Krajcinovic, D.; Srinivasan, M.G.; Valentin, R.A. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 15p. Dep. NTIS $3.50.

From 13. annual meeting of the Society of Engineering Science, Inc.; Hampton, Virginia, United States of America (USA) (1 Nov 1976).

The dynamic plastic response of a thin cylindrical shell, immersed in a potential fluid initially at rest, subjected to internal pressure pulse of arbitrary shape and duration is considered. The shell is assumed to respond as a rigid-perfectly plastic material while the fluid is taken as inviscid and incompressible. The fluid backpressure is incorporated into the equation of motion of the shell as an added mass term. Since arbitrary pulses can be reduced to equivalent rectangular pulses, the equation of motion is solved only for a rectangular pulse. The influence of the fluid in reducing the final plastic deformation is demonstrated by a numerical example.

25175 (SAND—76-0311) **Calculating the ablation of large spheres entering the atmosphere at meteoric velocities.** Wright, G.F. Jr.; McBride, D.D. (Sandia Labs., Albuquerque, N.Mex. (USA)). Dec 1976. Contract E(29-1)-789. 47p. Dep. NTIS $4.00.

The ablation of large spherical bodies entering the earth's atmosphere at meteoric velocities is calculated for a range of initial diameters, velocities, and reentry angles. An expression for the total mass loss is derived which includes the effects of thermal radiation, convective heat transfer, and the mass blowing effect on the boundary layer. The solution is coupled with the trajectory to account for changes in ballistic coefficient during ablation. Plots of the radiative heat-transfer rate are also presented.

25176 (Y—2067) **Compensation for the shape of a contour grinding wheel using computer numerical control.** Barkman, W.E.; Morris, T.O. (Oak Ridge Y-12 Plant, Tenn. (USA)). Jan 1977. Contract W-7405-ENG-26. 21p. Dep. NTIS $3.50.

An Allen-Bradley Company 7300 Computer Numerical Control (CNC) system has been interfaced with a two-axis machine tool in Oak Ridge Y-12 Plant to utilize on-machine tool-path adjustment to compensate for parameter variations in the contour grinding process. Hemishell test parts machined without compensation for grinding wheel size or shape deviated from the desired contour by as much as 48.26 μm (1.8 mils). Use of the wheel-shape compensation techniques reduced this deviation to 10.16 μm (0.4 mil).

25177 Double cell assembly (28 Jun 1972) (Engineering Materials). (California Univ., Livermore (USA). Lawrence Livermore Lab.). (CAPE—2544).

8 drawings.

A set of drawings is given for a double cavity absorption cell primarily used in laser spectroscopy. A laser beam can be passed through the two cavities, and fluorescence may then be observed through the sapphire window mounted on each cavity. The amount and wavelength of the fluorescence depends upon the type of laser used and the corresponding type or mixture of gas introduced into the two cavities. These devices have been most frequently used intra-cavity with a CW CO_2 laser, with the cells filled with CO_2. The fluorescence produced is then detected by an indium-antimonide detector mounted over the sapphire window. The fluorescence wavelength is in the 4.5 μm region. The strength of the fluorescence varies with the internal power of the lasers. The cell may be used in other areas of the spectrum and for other applications by choosing the correct optical components to suit the application.

25178 Argus focus lens mount (12 Jan 1976) (Engineering Materials). (California Univ., Livermore (USA). Lawrence Livermore Lab.). (CAPE—2543).

40 drawings.

Drawings are given for mounts for holding and positioning the main beam-focusing lenses on the target chamber of LLL's Argus laser-fusion system. The target chamber as a whole is described in Report UCRL-77248, "Argus Target Chamber."

25179 Stark cell No. 2 assembly (15 Oct 1976) (Engineering Materials). (California Univ., Livermore (USA). Lawrence Livermore Lab.). (CAPE—2537).

10 drawings.

Drawings are given for a Stark cell. Details include the assembly, cover chamber, body chamber, upper and lower electrodes, ball corona, bar clamp, housing, button spacer, and support. (PMA)

25180 SHIVA "beta", "gamma", and "delta" spatial filters lenses (4 Jul 1976) (Engineering Materials). (California Univ., Livermore (USA). Lawrence Livermore Lab.). (CAPE—2538).

5 drawings.

Drawings are given of clear aperture lenses for use in high energy vacuum spatial filters. The lenses have aspect ratios of about 1:15, and the spectral design center for these singlets is 1,064 nm. The drawings include the beta lens, the Gamma lens, the Delta lens, BK-7 glass blanks, and the general 3rd order spherical abberation deviation from best fit sphere. (PMA)

25181 (BNL-tr—631) **Electromagnetic valve for admitting short gas pulses into vacuum devices.** Derevyankin, G.E.; Dudnikov, V.G.; Zhuravlev, P.A. (AN SSSR, Novosibirsk. Inst. Yadernoj Fiziki). 1975. Translated by S.J. Amoretty of IYaF—75-2. 6p. Dep. NTIS $3.50.

An electromagnetic valve, capable of operating at 10^2 to 10^3 Hz for thousands of hours is described. The design of the valve and its power supply are presented. (TFD)

25182 Device for mounting plastic non-rigid tubes in evaporators. Lauro, F. (to Commissariat a l'Energie Atomique). US Patent 3,974,022. 10 Aug 1976. Priority date 7 Sep 1973, France. 4p.

In evaporators for distillation or concentration of solutions, each tube nest consists of non-rigid plastic tubes through which vapor is circulated. Each tube is secured to the fixed structure of the evaporator at the vapor admission end of the tube by means of a

standard fastening member and at the vapor discharge end by means of a sliding tubular expansion joint of small cross-sectional area compared with that of the tube.

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 24317, 24318, 24319, 24855, 25005, 25677, 25678, 25679

25183 (LBL—4948) **Operating manual for 200 kG pulse magnet.** Hemachalam, K. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1976. Contract W-7405-ENG-48. 24p. Dep. NTIS $3.50.

High field magnets have become necessary for measuring properties of superconducting materials. The generation of steady high magnetic field by conventional copper magnets or by superconducting magnets requires great cost for construction as well as operation. Transient fields, however, can be produced less expensively. For this reason, it has been customary to measure high-field properties of superconductors in pulsed magnets. The objective of the report given is two-fold: (1) to describe a pulse magnet apparatus in use at this Laboratory, and (2) to present an operating procedure to measure current-carrying behavior of superconductors as a function of magnetic field.

PROTECTIVE STRUCTURES AND EQUIPMENT

25184 **Respirator cartridge efficiency studies. VI. Effect of concentration.** Nelson, G.O.; Harder, C.A. (Univ. of California, Livermore). *Am. Ind. Hyg. Assoc. J.;* 7: No. 4, 205-216(Apr 1976).

The service life of organic vapor cartridges was determined for ten vapors at concentrations between 50 and 3000 ppM. The breakthrough time (t/sub b/) conformed to the empirical expression t/sub b/ = aC/sup b/, where C is the concentration in ppM and a and b are constants. The average value for b at 10 percent breakthrough was -0.67 +- 0.17. The service life is inversely proportional to flow rate for acetone and benzene.

HANDLING EQUIPMENT AND PROCEDURES

25185 (BNWL—2129) **Critical experiments measuring the reactivity worths of materials commonly encountered as fixed neutron poisons.** Bierman, S.R.; Durst, B.M.; Clayton, E.D. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Oct 1976. Contract E(45-1)-1830. 25p. Dep. NTIS $4.00.

There is a continuing interest in the use of fixed neutron absorbers (poisons) for criticality control, since their use would permit safely handling larger quantities of nuclear materials with reduced probability of criticality. The effectiveness of such absorbers as neutron poisons depends on self-shielding effects which in turn are determined by the magnitude of the absorption cross sections and their variation with energy, the thickness of material, and the neutron energy spectrum. Experiments were previously performed, and reported on, which provided data on the reactivity worths of copper and copper containing 1 wt% cadmium at several thicknesses and in two different neutron energy spectrums. Results from similar experiments using 304-L steel, 304-L steel containing 1.1 wt% boron, 304-L steel containing 1.6 wt% boron, uranium depleted to 0.2 wt% ^{235}U, boral, cadmium, and lead as fixed poisons and sets of clean, well defined, poisoned critical assemblies that can be used to check calculational techniques and cross section data in two different neutron energy spectrums are presented. The measurement data, currently being reported, are limited to a single region of a given absorber material in each critical assembly. Combinations of absorber materials or multi-regions were not investigated; however, material thicknesses were varied from zero up to about 60 mm.

25186 **Decontaminating gloved boxes.** Volk, E.E.; Partridge, R.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Health Phys.;* 31: No. 2, 178-179(Aug 1976).

An acid wash method for the decontamination of gloved boxes, which had been used for handling ^{239}Pu and ^{233}U, is described. The costs of packaging contaminated gloved boxes as against the much reduced cost for the packaging of the materials removed during such decontamination procedures, which is necessary to meet ERDA requirements for storage in interim isolation, are compared.

SHIPPING CONTAINERS

25187 (HEDL-TI—76-018) **HEDL Model 120 shipping container safety analysis report for packaging (SARP). Unirradiated fissionable materials.** Colton, L.B.; Rogers, C.A. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1976. Contract E(45-1)-2170. vp. AT.

A container that consists of an 11.94-in. ID containment vessel centered within a 21.5 x 21.5 x 190 in. metal birdcage is described. An analysis is made of structural integrity under normal conditions for transportation and under hypothetical accident conditions. Batch limits and transport indices are given for shipments of fuel pins, fuel assemblies, and other special-form materials.

25188 (LA—6640-MS) **Evaluation of analysis methods for Type B shipping container impact problems.** Counts, J.; Payne, J.B. (Los Alamos Scientific Lab., N.Mex. (USA)). Jan 1977. Contract W-7405-ENG-36. 16p. Dep. NTIS $3.50.

Several methods for predicting the impact response of shielded shipping containers for radioactive materials are discussed. Permanent lead deformations predicted by the methods are compared with available experimental results. A lumped-mass technique for the iterative process of dynamic design is recommended for further development.

25189 (LA—6642-MS) **Comparison of predicted and measured drop test responses to Type B shipping containers.** Counts, J.; Payne, J.B. (Los Alamos Scientific Lab., N.Mex. (USA)). Jan 1977. Contract W-7405-ENG-36. 11p. Dep. NTIS $3.50.

The dynamic response of full-scale and scale model impacting shipping containers predicted by the computer code IMPAC2 is compared with available experimental results. A more accurate mathematical model proposed for impacting containers is discussed.

25190 (LA—6643-MS) **IMPAC2: a lumped-mass nonlinear spring computer program to analyze Type B shipping container impact problems.** Counts, J.; Payne, J.B. (Los Alamos Scientific Lab., N.Mex. (USA)). Jan 1977. Contract W-7405-ENG-36. 33p. Dep. NTIS $4.00.

Information is provided for using the computer program, IMPAC2, which is designed to analyze the dynamic response of metallic shipping containers impacting an unyielding surface. The method of analysis, a description of the program, and an explanation of the input and output variables are presented.

25191 (SAND—76-0595) **Status of radiation shield design for liquid metal fast breeder reactor spent fuel shipping cask application.** Dupree, S.A.; Rack, H.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1976. Contract E(29-1)-789. 33p. Dep. NTIS $4.00.

Neutron and gamma-ray transport calculations in one-dimensional cylindrical geometry have been performed on a trial reference LMFBR spent-fuel shipping cask that could transport one CRBR subassembly. In the study it was assumed that a layer of depleted U and a layer of neutron shielding materials were sandwiched between 5.08-cm-thick (2-in.) layers of stainless steel. The thicknesses of the internal layers were adjusted until a balanced dose rate (50 percent neuton and 50 percent gamma-ray) of 5 mrem/hr was achieved at a point 1.83 m (6 ft) from the cask surface. Neutron-shield materials considered were LiH, Be, B_4C, $DiH_{3.4}$, and C (graphite). Of these materials, LiH provided the smallest, lightest, and least expensive cask; however, its use would be contigent on expansion of production facilities for LiH and development of a canning or cladding procedure. The B_4C shielded cask would offer the best alternative if the designs were limited to those using currently available materials.

LASERS

REFER ALSO TO CITATION(S) 25178, 25692

25192 (LA—6510-PR, pp 56-74) **New laser research and development.** Nov 1976.

In Laser fusion program at LASL. Progress report, January 1—June 30, 1976.

New types of lasers must be developed to provide the desired energy per pulse, pulse length, pulse shape, wavelength, and efficiency for laser-fusion applications. This advanced laser research has focused on rare-gas oxides and on Hg_2 excimers.

25193 (LA—6510-PR) **Laser fusion program at LASL. Progress report, January 1—June 30, 1976.** Stark, E. (Los Alamos Scientific Lab., N.Mex. (USA)). Nov 1976. Contract W-7405-ENG-36. 135p. Dep. NTIS $6.00.

Progress in the development of high-energy short-pulse CO_2 laser systems for fusion research is reported. The Single-Beam System continued to be used in target experiments at a peak intensity of 7×10^{14} W/cm^2, and the system was improved. The status of the Two-Beam System, on which target experiments have begun with 300-J, 1-ns pulses in one beam, is described. Construction and checkout of the Eight-Beam System are continuing. Further design studies for the High-Energy Gas Laser Facility and the initiation of a prototype program are reported. The rare-gas oxides and dimeric mercury were emphasized in investigations into new lasers for fusion research. Experimental kinetics studies, a study of heat-pipe containment of metal vapors, theoretical support, and optical-damage investigations are described. Significant experimental and theoretical results are reported on the question of wavelength-scaling in laser-

plasma interaction physics. Studies of vacuum insulation as a means of preventing target preheat by hot electrons are also summarized. Analyses of the ponderomotive force in laser-plasma interactions and of the relationship between x-ray spectrum and suprathermal electron distribution are described. Improvements to the MCRAD and LASNEX design codes are outlined, and a LASNEX analysis of a target heated by laser-generated fast ions is discussed. Improved methods of screening, characterizing, and fabricating microballoons and more complex targets are described, and progress in applying uniform layers of DT ice on the inside of a microballoon is reported. Improvements in diagnostics include x-ray streak photographs, the fabrication of x-ray microscope systems, and x-ray film imaging. New results in our feasibility and systems studies are presented, including the wetted-wall and magnetically protected reactor concepts, the effect of ionized debris on cavity walls, the fusion-fission breeder concept, and the production of synthetic fuels by fusion radiation.

25194 (LA-UR—76-2076) **Tunable diode laser spectroscopy.** Flicker, H.; Nereson, N.; Aldridge, J.P. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 4p. (CONF-761209—1). Dep. NTIS $3.50.

From 2. international conference of submillimeter waves and their applications; San Juan, Puerto Rico (Dec 1976).

The techniques of diode laser spectroscopy, recent results on enriched isotopic mixtures of CO_2, and some work in progress are discussed.

25195 (UCID—17350) **Status of Navy "dirty air" breakdown research.** Edwards, A.; Fleck, J.A. Jr. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Dec 1976. Contract W-7405-ENG-48. 14p. Dep. NTIS $3.50.

The LASNEX code has been upgraded to include optical ray tracing of laser light through the dynamically changing Lagrangian hydrodynamic mesh. Calculations have been carried out to simulate the absorption of laser light by a two-dimensional breakdown plasma initiated by a vaporizing dust particle.

25196 (UCID—17356) **Calculation of the small scale self-focusing ripple gain spectrum for the CYCLOPS laser system: a status report.** Fleck, J.A. Jr.; Morris, J.R.; Thompson, P.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Oct 1976. Contract W-7405-ENG-48. 15p. Dep. NTIS $3.50.

The FLAC code (Fourier Laser Amplifier Code) was used to simulate the CYCLOPS laser system up to the third B-module and to calculate the maximum ripple gain spectrum. The model of this portion of CYCLOPS consists of 33 segments that correspond to 20 optical elements (simulation of the cell requires 2 segments and 12 external air spaces). (MHR)

25197 (UCRL—13682) **Research studies on techniques for generation of ultraviolet and vacuum ultraviolet radiation. Final report, 15 February 1975—14 February 1976.** (Stanford Univ., Calif. (USA)). Apr 1976. Contract E(04-3)-326. 82p. Dep. NTIS $5.00.

Phase matched third harmonic generation in sodium and rubidium vapor using both an inert gas and a second metal vapor for phasematching is demonstrated. Energy conversion efficiencies of 10 percent have been obtained and factors limiting conversion efficiencies are discussed. Theoretical analysis for a resonantly two-photon pumped frequency converter with application to the generation of tunable ultraviolet and vacuum ultraviolet radiation and also to infrared-to-visible up-conversion and imaging is presented. Calculations show that up-conversion power efficiencies in excess of 100 percent should be obtainable with tunable lasers having peak powers in the hundred watt to kilowatt range. Efficient up-conversion of low-level infrared radiation near 10 μm to the near ultraviolet employing resonant two-photon pumping of a non-allowed transition in sodium vapor is demonstrated.

25198 (UCRL—13708) **Research on high-energy storage for laser amplifiers. Final report.** Black, G. (Stanford Research Inst., Menlo Park, Calif. (USA)). 10 Dec 1976. Contract EY-76-C-03-0115-096. 53p. Dep. NTIS $4.50.

The Gr VI metastables—O(^{1}S), S(^{1}S) and Se(^{1}S)—are of interest as high-energy lasers for laser fusion applications. Their production was investigated by the photodissociation of triatomic molecules in the vacuum ultraviolet. High quantum yields for the production of O(^{1}S) from N_2O, S(^{1}S) from OCS and Se(^{1}S) from OCSe have been measured in regions of strong absorption assigned as ^1ui reverse arrow ^1ui transitions. This does not hold for CS_2, however, as S(^{1}S) is not produced by photodissociation in the region of the strong ^1ui/sub u/ reverse arrow ^1ui/sub g/ transition (f = 1.1) between 1880 and 2100 A. In addition to finding efficient means for producing these excited states, rate coefficients were also measured for their removal by collision-induced emission and quenching. Photodissociation techniques were applied to generate short-lived electronically excited species which may find application as photolytic light sources for both photodissociation and isotope separation. The experiments utilized a vacuum ultraviolet flashlamp with a lifetime of approximately 3 nsec and single photon detection. Measurements of radiative lifetimes and quenching properties are reported for OH* from H_2O, CS* from CS_2, I_2* from CH_2I_2 and Cl_2* from $COCl_2$. Strong effects of rotational and vibrational excitation on radiative lifetimes were found. Interestingly, most of the emission in the 2000 to 3000 A region produced by CS_2 photodissociation at Lyman α arises from triplet state(s) of CS that are perturbed by the $A^1\Pi$ state rather than from the $A^1\Pi$ state itself. Radiative lifetimes of 12 +- 1 nsec were found for the I_2* from CH_2I_2 and 10 +- 1 nsec for the Cl_2* from $COCl_2$. A separate abstract was prepared for Appendix A.

25199 **LLL "standard" flashlamp (16 Sep 1975) (Engineering Materials).** (California Univ., Livermore (USA). Lawrence Livermore Lab.). (CAPE—2541).

1 drawing.

A drawing is given of a flashlamp for a glass laser system.

25200 **"Beta" disk amplifier (21 Oct 1976) (Engineering Materials).** (California Univ., Livermore (USA). Lawrence Livermore Lab.). (CAPE—2536).

43 drawings.

Drawings are given for a Nd:glass laser amplifier, currently used in LLL's SHIVA laser system, provides a net gain of greater than or equal to 3.9 at 1064 nm when pumped with 140 kJ. It has consistently demonstrated this performance for over 1000 firings. It has a clear aperture of 95 mm and is cleaner and hence provides less beam degradation (due to obscurations) than all preceding disk amplifiers (except the B75) of otherwise comparable performance with subnanosecond pulses. The Beta is less expensive and has slightly higher gain than the B75, but requires more extensive assembly jigging.

25201 **Various materials on construction of a low pressure stable CO_2 laser (17 Apr 1972 (Engineering Materials).** (California Univ., Livermore (USA). Lawrence Livermore Lab.). (CAPE—2488/1).

130 drawings.

Drawings are given for components of a low pressure stable CO_2 laser. Details include the high voltage monitor and control, laser assembly, grating wave length selector, the discharge tube, the adjustable grating assembly, and the grating and iris holder. (PMA)

25202 **High energy glass lasers.** Glaze, J.A. (Univ. of California, Livermore). *Opt. Eng.;* **15**: No. 2, 136-142(1976).

To investigate intense pulse propagation phenomena, as well as problems in laser and system design, a prototype single chain laser called CYCLOPS was fabricated and operated. This laser employs a 20-cm clear aperture disk amplifier in its final stage and produces a terawatt pulse whose brightness exceeds 10^{18} watts/cm^2-ster. The CYCLOPS system is summarized and aspects of nonlinear propagation phenomena that are currently being addressed are discussed. (MHR)

25203 **Lasers.** Bradley, D.J.; Hutchinson, M.H.R. (to National Research Development Corp.). US Patent 3,983,508. 28 Sep 1976. Priority date 19 Mar 1975, United Kingdom of Great Britain and Northern Ireland (UK). 4p.

A laser comprises a cell containing xenon at high pressure and has its walls pervious to high-velocity electrons. The cell is of cylindrical shape and constitutes the anode of a field-emission diode with the cathode of the diode surrounding the anode. Electrons emitted from the cathode thus travel radially inwardly and penetrate the anode walls to excite lasing action.

25204 **Nozzle for free jet dye laser.** Pike, C.T. (to Jersey Nuclear-Avco Isotopes, Inc.). US Patent 3,984,786. 5 Oct 1976. Filed date 28 May 1975. 6p.

A nozzle for a free jet dye laser is described wherein the nozzle orifice has an adjustable convex contour to permit realization of precisely plane parallel sides in the central jet region. A jet of this precision is desired to support a high quality laser beam for use in laser enrichment apparatus. The precise planar characteristic of the central portion of the jet is achieved by a narrowing of the central portion of the nozzle orifice. A set of adjustment screws are provided to define the specific contour of the narrowing to insure that the sides of the free jet are precisely plane parallel. A system is shown for detecting the degree to which the sides are plane parallel so that an optimum adjustment in the orifice can be achieved.

25205 **Method of making a substrate striped planar laser.** Burnham, R.B.; Scifres, D.R. (to Xerox Corp.). US Patent 3,984,262. 5 Oct 1976. Filed date 9 Dec 1974. 6p.

A method of making a diode laser is described in which a pump current confining channel is formed on the n-side of the diode laser prior to the growth of the active region of the diode laser. The current confining channel is formed by providing two spaced regions in a substrate with the regions being highly resistive to current flow when the diode laser is forwarded biased. Preferably, the regions are formed by diffusion of an impurity into a substrate of a selected conductivity type so as to form secondary p—n junctions on

both sides of an intermediate channel, with subsequent growth of other layers of the diode laser providing a primary p—n junction at the boundary of the active laser region. Forward biasing of the primary p—n junction results in reverse biasing of the secondary p—n junctions and pump current confinement to the channel.

25206 Expander open cycle gas dynamic laser. Pinsley, E.A. (to United Technologies Corp.). US Patent 3,984,784. 5 Oct 1976. Filed date 19 Dec 1974. 4p.

This device includes an expander open cycle gas dynamic laser wherein the majority of the gas dynamic laser flow is recirculated while a fraction of the flow is removed in a boundary layer bleed removal system. This device includes a combustor for providing the proper gas constituents which then flow downstream of a nozzle means in a laser cavity to permit lasing to occur. The flow from the lasing cavity is directed into a diffuser which in turn directs its flow into the inlet of a compressor after flowing over a heat exchanger which cools the flow. One heat exchanger is in the bleed flow while the other is in the flow from the diffuser. The flow from the compressor is directed into the combustor.

25207 Apparatus to transform a single laser beam into two parallel beams of adjustable spacing and intensity. Zanoni, C.A. (to Zygo Corp.). US Patent 3,984,153. 5 Oct 1976. Filed date 15 May 1974. 4p.

An optomechanical apparatus is described which transforms a single laser beam into two parallel beams of adjustable spacing and intensity. The distance between the two output beams can be varied continuously over a wide range, and the distance between the output beams can be reduced to zero. By splitting a polarized laser beam into two beams of orthogonal polarization with a polarization beam splitter, by redirecting the reflected beam with a stationary roof prism, a stationary pentaprism, and a movable pentaprism such that the reflected beam is rereflected by the opposite side of the polarization beam splitter, two beams of variable intensity and of nominal parallelism are produced. A suitably placed pair of counterrotating wedges permits alignment of the beams to a high degree of parallelism.

25208 Method for producing chemical laser output from radiative decomposition of chemicals. Ehrlich, J.J.; Barr, T.A. Jr. (to Secretary of the Army). US Patent 3,986,137. 12 Oct 1976. Filed date 30 Sep 1974. 4p.

A method is described for producing continuous wave chemical laser output in which useful species such as free radicals as vibrationally excited molecules are generated by interaction of suitable chemicals such as hydrogen, sulfur hexafluoride, and carbon dioxide with initiator laser radiation. The chemical laser output is sustained by feeding back a portion of the laser output after first being initiated by a suitable initiator. The chemical reactions involved can take place at atmospheric pressure or higher and overcome disadvantages of ordinary chemical lasers.

25209 Gas discharge laser. Bulthuis, K.; Van der Wal, J.; Derksema, B.J. (to U.S. Philips Corp.). US Patent 3,986,141. 12 Oct 1976. Priority date 28 Feb 1974, Netherlands. 2p.

A gas discharge laser is described in which a plane parallel transparent plate whose normal encloses an angle with the axis of the laser tube equal to the Brewster angle is arranged in at least one of the ends of the laser tube. The plate is secured to the adjacent reflector so that the plate can easily be replaced.

25210 Isothermal gas dynamic laser nozzle. Neal, J.W. (to Secretary of the Air Force). US Patent 3,986,138. 12 Oct 1976. Filed date 29 Mar 1974. 4p.

A gas laser is described that is comprised of two identical hollow nozzle portions which are positioned in layered fashion (i.e., in stacked condition), in registration, and with their respective longitudinal axes in parallel. Each nozzle portion has a protrusion extending into the void or hollow interior, and coolant flow passages are located in the protrusion. The internal surface of each nozzle portion has a nickel fiber wick sintered to it, and the wick is saturated with a metal, preferably sodium, which is in a liquid state. The unique structure of the inventive nozzle permits a very short transient start and also permits operation of the nozzle at steady-state conditions in an isothermal manner. 2 claims, 4 drawing figures.

25211 Radioactively preionized electrical discharge laser. Meneely, C.T.; Schlossberg, H. (to Secretary of the Air Force). US Patent 3,986,139. 12 Oct 1976. Filed date 18 Feb 1975. 4p.

A miniature TEA laser system is described having a pair of electrodes mounted within the laser cavity and a radioactive source in the form of a beta particle emitter located within the cavity adjacent the electrodes. The electrodes are spaced no more than the maximum beta particle range apart so that the radioactive emission can take place within the space between electrodes therby uniformly preionizing the active laser medium within the cavity.

25212 Chemical laser from radiative decomposition of chemicals. Ehrlich, J.J.; Barr, T.A. Jr. (to Secretary of the Army). US Patent 3,987,372. 19 Oct 1976. Filed date 30 Sep 1974. 4p.

A continuous wave chemical laser device is described in which useful species such as free radicals as vibrationally excited molecules are generated by interaction of suitable chemicals such as hydrogen sulfur hexafluoride, and carbon dioxide with laser radiation. The chemical laser device is capable of generating active species by interaction of its own laser radiation after first being initiated by a suitable initiator. The chemical reactions involved can take place at atmospheric pressure or higher and overcome disadvantages of ordinary chemical lasers.

25213 (SAND—77-6000) Evaluation of bleaching losses in the iodine laser translation. Witte, K.J. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). 10 Jan 1977. Translation by B. Teague of IPP-IV—88. 35p. Dep. NTIS $4.00.

Because of the variable transparency of C_3F_7I, the pump light energy absorbed in the oscillator mode is larger than the pump light energy absorbed in the amplifier mode. The evaluation of the difference, here called "bleaching losses," important in the case of final amplifiers of high-power lasers, is studied in this investigation. It is shown that the ratio of these two energies is equivalent to the ratio of the optical energy stored in the amplifier mode and the energy released in the oscillator mode.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 23985, 24464, 24509, 24614, 24727, 24738, 24752

25214 (CONF-761107—22) Hydrodynamic instability induced liquid—solid contacts in film boiling. Yao, S.; Henry, R.E. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 11p. Dep. NTIS $3.50.

From Annual meeting of the American Society of Mechanical Engineers; New York, New York, United States of America (USA) (29 Nov 1976).

The film boiling liquid-solid contacts of saturated ethanol and water to horizontal flat gold plated copper are examined by using electric conductance probe. It is observed that the liquid-solid contacts occur over a wide temperature range, and generally, induced by hydrodynamic instabilities. The area of contact decreases exponentially with interface temperature and is liquid depth dependent. The averaged duration of contacts is strongly influenced by the dominant nucleation process, and thus, depends on the interface temperature and the wettability of the solid during the contact. The frequency of major contacts is about 1.5 times the bubble detaching frequency. It is found that the liquid-solid contacts may account for a large percentage of the film boiling heat transfer near the low temperature end of film boiling and decreases as the interface temperature increases.

25215 (COO—4062-2) Modeling two-phase flow in a swirl combustor. Technical progress report, October 9—December 3, 1976. Lewellen, W.S.; Segur, H.; Varma, A.K. (Aeronautical Research Associates of Princeton, Inc., N.J. (USA)). Dec 1976. Contract EY-76-C-02-4062. 21p. Dep. NTIS $3.50.

Progress made toward modeling two-phase flow in a swirl combustor is outlined. Work has concentrated on developing a phenomenological model to guide proper scaling. This simple model will also serve as a skeleton for the more detailed computer model which will be developed in the next few months. Scaling relations indicate that the PERC design for the first stage gasifier-combustor for the CDIF should have a higher carbon conversion efficiency, but is likely to have a slightly higher ash carry-over than that which occurs in PERC's laboratory scale model. If desired, the carry-over may be reduced by decreasing the fraction of small coal particles. It also appears that the total pressure drop will be somewhat larger.

25216 (INEL-TR—9) Two-phase flow measurements. Delhaye, J.M. Translated from *Bull. Inf. Sci. Tech. (Paris);* No. 197, 5-20(1974). 36p. Dep. NTIS $4.00.

The methods used to measure the following quantities are described briefly: amount of one phase present over a segment or in a section, mean liquid phase velocity in a section, quality, total mass flow rate, local void fraction, local liquid velocity and local temperatures of each phase. The methods or instruments involved are as follows: x- or γ-ray absorption, electromagnetic flowmeter, turbine flowmeter, variable pressure-drop meter, hot-wire anemometry, resistive probes, phase-indicating thermocouple, and optical probes.

25217 Finned tube for heat exchangers. Gropp, R.; Zenn, H. (to Metallschlauch-Fabrik Pforzheim (Germany, F.R.)). German(FRG) Patent 2,320,497/A/. 16 Jan 1975. 19p. (In German).

10 figs. Available from Dt. Patentamt, Muenchen (FRG).

The described finned tube consists of a tube and a screw thread shaped strip around the latter which is firmly heat-conducting connected to the tube. The tube is made of a band by welding, soldering, folding, sticking of neighboring band edges and is de-

signed to have a screw thread rippling onto which the above-mentioned strip is attached.

25218 Heat exchangers for hydrodynamic-mechanical transmissions. Aahlen, K.G. (to S.R.M. Hydromekanik AB). German(FRG) Patent 2,505,640/A/. 25 Sep 1975. 21p. (In German).

6 figs. Available from Dt. Patentamt, Muenchen (FRG).

This is a heat exchanger for a hydrodynamic-mechanical transmission the torque converter of which at the same time may be used as pinion brake. The heat exchanger supplies maximum cooling power at small dimensions and a practical shape while the pressure drop on the oil side as well as on the cooling water side is much lower than with conventional heat exchanger designs. Morover, the heat exchanger is less sensitive to fast temperature changes than the heat exchangers now known.

25219 Melting heat transfer in steady laminar flow over a flat plate. Epstein, M.; Cho, D.H. (Argonne National Lab., IL). *J. Heat Transfer;* **98**: No. 3, 531-533(Aug 1976).

Exact similarity solutions for melting heat transfer in steady laminar flow over a flat plate were collected from the diffusional mass transfer literature to provide solutions for Prandtl numbers from 0.001 to 100. An exact closed-form solution is introduced for the case of melting in porous media. The results are presented and discussed in such a way as to emphasize the similarity between melting and diffusional mass transfer.

25220 Pressure loss and phase distribution of a steam/water mixture in a pipe with horizontal flow. Frass, F. (Univ., Vienna); Wiesenberger, J. *Brennst.-Waerme-Kraft;* **28**: No. 9, 358-362, 363(Sep 1976).

The coefficients of two-phase pressure loss, which were so far mostly determined at lower pressure (up to 30 bar), up to pressures of 170 bar are discussed. The basic relations for the determination of pressure losses for a two-phase mixture are given, and the testing installation described. The calculation of the pipe friction number, the measurement of the phase distribution and the steam residing time are described. The test results show that the coefficient of two-phase friction for laminated flow differ from those of circular flow, and that in general they are lower.

25221 Bubble growth in the presence of a magnetic field. Lykoudis, P.S. (Purdue Univ., West Lafayette, IN). *Int. J. Heat Mass Transfer;* **19**: No. 12, 1357-1362(Dec 1976).

The problem of the growth of a bubble in the presence of a magnetic field is examined under the assumption that the process is heat transfer controlled. The work reveals the existence of a new nondimensional number which physically represents the ratio of the ponderomotive forces over pressure forces computed on the basis of length-scale and time related to the coefficient of thermal diffusion. It is found that for a spherical magnetic field, growth of the bubble remains parabolic in time but the rate of growth is slower. Heat-transfer estimates are also made in the fashion of Forster and Zuber indicating that heat transfer in nucleate boiling is reduced in the presence of magnetic fields. In a numerical example, this reduction is more substantial for potassium than it is for mercury. The problem has application in two-phase liquid-metal MHD generator design and fusion reactor blanket design.

MATERIALS TESTING

REFER ALSO TO CITATION(S) 24523

25222 (CONF-760903—6) **Three-dimensional thermal neutron radiography.** Parker, W.L.; Berger, H.; Lapinski, N.P.; Reimann, K.J. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 7p. Dep. NTIS $3.50.

From 8. world conference on nondestructive testing; Cannes, France (6 Sep 1976).

Three-dimensional radiography with thermal neutrons is described. The laminagraphic method is shown to provide a spatial resolution better than 1 mm for complex objects as thick as 50 mm.

25223 (SAND—76-0651) **Stop-motion radiography.** Mottern, R.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). Dec 1976. Contract E(29-1)-789. 30p. Dep. NTIS $5.00.

A variety of radiographic techniques used at Sandia Laboratories to examine dynamic events is described. The techniques, while not interfering with the events, make possible recording of data not obtainable by other means. The events being recorded may occur within microseconds or may require a time span of many seconds. The arrangement of equipment and various methods of image recording are discussed.

SAFETY ENGINEERING

25224 (UCRL—78073) **Numerical simulation of tornado wind loading on structures.** Maiden, D.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1976. Contract W-7405-ENG-48. 17p. (CONF-761110—2). Dep. NTIS $3.50.

From 13. annual meeting of the Society of Engineering Science, Inc.; Hampton, Virginia, United States of America (USA) (1 Nov 1976).

A numerical simulation of a tornado interfacing with a building was undertaken in order to compare the pressures due to a rotational unsteady wind with that due to steady straight winds currently used in design of nuclear facilities. The numerical simulations were performed on a two-dimensional compressible hydrodynamics code. Calculated pressure profiles for a typical building are then subjected to a tornado wind field and the results are compared with current quasisteady design calculations. The analysis indicates that current design practices are conservative.

VACUUM ENGINEERING

REFER ALSO TO CITATION(S) 25181

ELECTRONIC CIRCUITS AND DEVICES

REFER ALSO TO CITATION(S) 25250, 25729

25225 (LBL—5567) **Excess noise in selected field-effect transistors.** Llacer, J.; Meier, D.F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1976. Contract W-7405-ENG-48. 12p. (CONF-761006—31). Dep. NTIS $3.50.

From Nuclear science, scintillation and semiconductor counter symposium; New Orleans, Louisiana, United States of America (USA) (20 Oct 1976).

The origin of excess noise in high-quality FETs is investigated in the frequency domain. It is found that, for use in opto-feedback systems, generation-recombination noise through deep traps is important. It is shown that best initial characterization of transistors for that use can be done in a grounded gate configuration. The activation energy of the principal traps responsible for the g-r noise is calculated and tentative identification of the responsible impurities or defects is made. It is also shown that the basic low temperature limit of Si FET operation is set by majority carrier freeze out at chip temperatures well above 100°K and that boron nitride mounts at temperatures above 77°K can contribute 10 to 15 eV of 1/f noise.

25226 Titration amplifier and ion selective probe amplifier (Aug 1976) (Engineering Materials). (California Univ., Livermore (USA). Lawrence Livermore Lab.). (CAPE—2539).

2 drawings.

Drawings are given for high input impedance, low drift amplifiers suitable for conditioning ion selective electrode output voltages, so that the data are ready for analog-to-digital (A/D) conversion and subsequent computer use. The amplifiers have low limit and range settings so that the full dynamic range of a 0 to 10 volt A/D converter can be used. They also have a 0 to 10 μa. current source which is used in special titrations. The only difference in the low amplifiers is that LEA 76-1698-110 is of higher accuracy and lower drift.

25227 Speed microprocessor (May 1975) (Engineering Materials). (California Univ., Livermore (USA). Lawrence Livermore Lab.). (CAPE—2542).

3 drawings.

Drawings are given for a speed microprocessor which uses the microprocessor ready line in conjunction with a simple floppy-disc interface, rather than interrupt or direct-memory-access (DMA) techniques. Details of the floppy disc include the cable, timing, and data boards. (PMA)

25228 (SAND—76-6034) **Effect of an ion background on electron build-up in a high-current diode.** Ryutov, D.D.; Stupakov, G.V. (AN SSSR, Novosibirsk. Inst. Yadernoj Fiziki). 1976. Translation by P. Newman of IYaF—76-16. 23p. Dep. NTIS $4.00.

A cloud of fast electrons forms close to the anode film of a high-current vacuum diode placed in a strong longitudinal magnetic field; two stages can be seen in the process of cloud buildup. In this paper several effects which arise when a neutralizing ion background is taken into account are considered; the existence of a plasma behind the film is assumed. The presence of ions in the diode gap leads to a fundamental change in the operation of the diode, which, in particular is expressed in the fact that the density of the cloud of oscillating electrons is not limited by any value, but continuously increases with time. It can considerably exceed the

cloud density at the initial moment when there are no ions. Under the influence of the field of the oscillating electrons, ions begin to flow from the vacuum side outside the diode film; the cloud expands in the longitudinal direction. An analytic solution describing this process was derived. This effect of electron cloud expansion can be used for transfer of the energy accumulated in the cloud to the load. 3 figures. (RWR)

SOLID WASTE PROCESSING PLANTS AND EQUIPMENT

REFER ALSO TO CITATION(S) 24911

25229 (ANL—76-XX-15) **Environmental costs of landfills and incinerators.** Hockman, O.; Hwang, E.G.; Rudzitis, G. (Argonne National Lab., Ill. (USA); Chicago Univ., Ill. (USA)). Jul 1976. Contract W-31-ENG-38;NSF-AG-352;NSF-GI-32989A2. 10p. Dep. NTIS $3.50.

After an introductory statement describing the characteristics of landfills and incinerators, these two devices for municipal waste disposal are compared in terms of economic and environmental costs. Cost data for the Chicago area is used. It is concluded that landfills have lower investment, operating and environmental costs. (LCL)

25230 (BM-IC—8460) **Bureau of Mines research and accomplishments in utilization of solid wastes.** Cservenyak, F.J.; Kenahan, C.B. (Bureau of Mines, Washington, D.C. (USA)). Mar 1970. 31p. Bureau of Mines, Washington, DC.

The Bureau of Mines Solid Waste Program is directed toward three main areas of research: (1) extraction of mineral, metal, and energy values from urban refuse; (2) recovery of mineral and metal values from wastes generated in the industrial extraction, processing, and utilization of raw materials and mineral-base products; and (3) upgrading and utilization of automotive scrap. The Bureau also has a contract and grant program which supplements the in-house research and aids in the training of personnel in the proper management of mineral- and metal-based solid wastes.

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 23983, 23984, 23986, 24298

25231 **System for the smokeless combustion of hydrocarbon gases.** Reed, R.D.; Schwartz, R.E. (to Zink (J.) Co.). German(FRG) Patent 2,361,498/A/. 19 Jun 1975. 15p. (In German).

4 figs. Available from Dt. Patentamt, Muenchen (FRG).

A description is given of a flare system or a system for the smokeless combustion of hydrocarbon gases where steam is used in order to create an exceptionally turbulent mixture of flare gas and air plus steam, and to thus achieve a complete combustion of the carbon. Several steam nozzles are used which are directed into the hydrocarbon gas column which comes out of the top of a flare chimney.

25232 **Method for operating a turbine using blast furnace gas produced by blast furnaces.** (to Vereinigte Oesterreichische Eisen- und Stahlwerke A.G. (VOeEST) - Alpine Montan). German(FRG) Patent 2,531,542/A/. 15 Apr 1976. 9p. (In German).

1 fig. Available from Dt. Patentamt, Muenchen (FRG).

A method is described for operating a turbine by means of blast furnace gas. The blast furnace gas is wet-cleaned and then heated before entering the turbine by a temperature value corresponding to the temperature lost when passing through the turbine. Heating is done by means of heat exchangers using the steam flow also used for cooling the blast furnace.

UNDERGROUND ENGINEERING

25233 (EPRI—7836) **System requirements and analysis of an experimental guided tunneler.** Ciavatta, A. (Ingersoll-Rand Research, Inc., Princeton, N.J. (USA)). Aug 1975. Contract E(49-18)-2127;EPRI-PRJ-7836. 181p. Dep. NTIS $7.50.

Existing or near existing methods of tunneling for the purpose of installing underground power transmission lines in downtown urban America are reviewed and a program for developing an experimental guided tunneler is recommended. Information is included on excavation requirements, general problems, excavation techniques, mucking, bore lining, retraction, steering and guidance, and procedures used in arriving at the recommendations for further development. (LCL)

PARTICLE ACCELERATORS

DESIGN, DEVELOPMENT, AND OPERATION

25234 (BNL—21800) **Linear accelerator development at Brookhaven National Laboratory.** Batchelor, K. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract E(30-1)-16. 10p. (CONF-760942—7). Dep. NTIS $3.50.

From Conference on proton linear accelerator; Ontario, Canada (14 Sep 1976).

A description is given of operating experience on the 200 MeV Proton Injector Linace of the A.G.S. emphasizing developments in field phase and amplitude control and beam diagnostics. Developments in auxilliary use of the machine are also described.

25235 **Simulation of the ion beam of the high frequency ion thruster RIT 10.** Haeuser, J. (Giessen Univ. (Germany, F.R.). 1. Physikalisches Inst.). *Raumfahrtforschung;* **20**: No. 4, 203-207(Jul 1976). (In German).

11 figs.; 9 refs.

During the last two years a program was developed at Giessen University which allows a simulation of the extraction system of a RIT 10 ion thruster for calculating and plotting the ion trajectories. The main problem was the definition of the plasma boundary and construction of an algorithm for its computation by iteration. The values calculated by the theory for the ion current and the divergence angle are in good agreement with experimental results. An application of the program to every other rf-ion source is possible.

25236 (SAND—76-6037) **Megampere electron ion nanosecond accelerator.** Kazanskii, L.N.; Kolomenskii, A.A.; Yablokov, B.N. (AN SSSR, Moscow. Fizicheskij Inst.). Nov 1976. Translation by P. Newman of Russian report. (CONF-760981—2). 11p. Dep. NTIS $3.50.

From 2. symposium on collective methods of acceleration; Moscow, Union of Soviet Socialist Republics (USSR) (29 Sep 1976).

An accelerator with the following beam parameters was considered as a design project: (1) power 10 TW; (2) impedance 0.05 Ohm; (3) current (electronic) 10 to 15 MA and (ionic) 1 to 3 MA; (4) kinetic energy 0.5 to 0.7 MeV; (5) stored energy approximately 150 kJ; (6) power pulse half-width approximately 30 ns; and (7) front length 15 to 20 ns. It is proposed to achieve these parameters by means of parallel supply to the diode from two modules. Consequently two types of problems can be solved on the accelerator. First, a 507 MA module can be developed for a larger, future facility, and secondly the one-two module device can be used for investigations in the field of considerably higher currents than are possible at the present time. It appears possible to design low-impedance modules suitable for parallel or series connection in larger facilities and to carry out a wide range of experiments with beam currents approximately greater than 5 to 10 MA in an accelerator with one or two modules.

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

25237 (BNL-tr—635) **Experimental study of electron cooling.** Budker, G.I.; Dikanskii, N.S.; Kudelainen, V.I.; Meshkov, I.N.; Parkhomchuk, V.V.; Pestrikov, D.V.; Skrinskii, A.N.; Sukhina, B.N. (AN SSSR, Novosibirsk. Inst. Yadernoj Fiziki). 1976. Translation by S.J. Amoretty of Preprint IYaF—76-33. 55p. Dep. NTIS $4.50.

In electron-positron storage rings the damping of particle oscillations is achieved by synchrotron radiation. Since this effect is practically absent in heavy-particle accelerators, multiple accumulation of particles is achieved by electron cooling. The method is as follows. A beam of electrons with the same average velocity and direction as that of the heavy particles is injected into one of the straight sections of a heavy-particle storage ring. The Coulomb interaction results in an exchange of energy between two kinds of particles, and if the electron beam is sufficiently monochromatic and has parallel particle trajectories, it will act as a refrigerator and absorb excess energy of the hot gas of heavy particles. In a coordinate system moving with the average particle velocity, this mixture of two intersecting beams is similar to a two-component plasma in which a temperature-equalizing process occurs. Results are given of experiments done in 1974-1975 on electron cooling of a proton beam. Although some of these results have been published, the more important results are included for completeness. Electron cooling makes possible multiple stacking of heavy particles. Studies have shown that by using this technique it is possible to stack intense antiproton beams that produce a luminosity of greater than or equal to 10^{31} cm^{-2} sec^{-1} of the proton-antiproton colliding beams.

AUXILIARIES AND COMPONENTS

REFER ALSO TO CITATION(S) 25679

25238 Increased cyclotron beam intensity using a harmonic beam interceptor. Mallory, M.L.; Hudson, E.D.; Hale, J.W. (Oak Ridge National Lab., Tenn. (USA)). *Nucl. Instrum. Methods;* **137**: No. 2, 379-380(1 Sep 1976).

A harmonic beam interceptor has been built for the Oak Ridge Isochronous Cyclotron (ORIC) and has increased the beam intensity on an experimental target for a space charge limited harmonic beam by as much as a factor of two.

25239 Non-destructive bunch length monitor for a proton linear accelerator. Witkover, R.L. (Brookhaven National Lab., Upton, N.Y. (USA)). *Nucl. Instrum. Methods;* **137**: No. 2, 203-211(1 Sep 1976).

A new approach is presented for measuring the longitudinal bunch density distribution in a proton linac which performs this measurement in a non-destructive manner and allows direct presentation on a slow X-Y display. The technique is based upon the coherent transferral of the density information from the protons in the bunch to secondary emission electrons released from a foil in the beam's path. These electrons are then energy modulated by the same rf used to accelerate the protons, and analyzed with a magnetic spectrometer. A probe of this type was installed in the 200 MeV linac at the Brookhaven National Laboratory. Measurements indicated an equivalent bandwidth of over 10 GHz, which agreed well with theory. The analysis suggests that with additional drive power the bandwidth could be increased by a factor of three or more.

EXPERIMENTAL FACILITIES AND EQUIPMENT

25240 (TID—27339) **Bevatron/Bevalac user's handbook: nuclear science.** (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1976. Contract W-7405-ENG-48. 150p. Dep. NTIS $6.00.

Lawrence Berkeley Laboratory presently has the most extensive array of heavy ion accelerators in the world, with a diverse research program in nuclear science, physics and the biological effects of heavy ion radiations. Of these, the Bevatron/Bevalac offers an extremely wide range of high energy, high intensity particle beams—from protons to argon and heavier. The facilities and experimental program have changed dramatically since 1974, when Bevalac operation was inaugurated. Now with SuperHILAC accelerated heavy ions injected into the Bevatron, intense beams of particles up to argon can be accelerated to energies of 2.1 GeV per nucleon. A handbook is given which describes administrative information, major facilities, operational data, experimental beam lines and experimental equipment for nuclear science and physics users.

STORAGE RINGS

25241 Aperture limitation due to random errors in superconducting magnets. Month, M.; Parzen, G. (Brookhaven National Lab., Upton, N.Y. (USA)). *Nucl. Instrum. Methods;* **137**: No. 2, 319-329(1 Sep 1976).

The presence of the current carrying coils within the iron shield of superconducting magnets has the effect of making the magnetic field within the magnet aperture sensitive to coil block positioning errors. In high current devices where a substantial fraction of the magnet aperture is to be used to stack particle beams, criteria based on a multipole analysis at the magnet center are inadequate. An analysis of the effect of coil block errors taking proper account of the multipole variation across the beam aperture is given. The implications for current accumulation within a given magnet aperture are considered in terms of both the distortions introduced into the linear beam orbits and the induced non-linear resonances.

INSTRUMENTATION

RADIATION INSTRUMENTATION

REFER ALSO TO CITATION(S) 25375, 25376

GENERAL DETECTORS AND MONITORS

REFER ALSO TO CITATION(S) 24054, 24372, 24683, 24716, 25377, 25378

25242 (BNWL—1991) **Technological considerations in emergency instrumentation preparedness. Phase II-D. Evaluation testing and calibration methodology for emergency radiological instrumentation.** Bramson, P.E.; Andersen, B.V.; Fleming, D.M.; Kathren, R.L.; Mulhern, O.R.; Newton, C.E.; Oscarson, E.E.; Selby, J.M. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1976. Contract E(45-1)-1830. vp. Dep. NTIS $9.00.

In response to recommendations from the Advisory Committee on Reactor Safeguards, the Division of Operational Safety, U.S. ERDA has contracted with Battelle, Pacific Northwest Laboratories to survey the adequacy of existing instrumentation at nuclear fuel cycle facilities to meet emergency requirements and to develop technical criteria for instrumentation systems to be used in assessment of environmental conditions following plant emergencies. This report, the fifth in a series, provides: (1) calibration methods to assure the quality of radiological measurements and (2) testing procedures for determining whether an emergency radiological instrument meets the performance specifications. Three previous reports in this series identified the emergency instrumentation needs for power reactors, mixed oxide fuel plants, and fuel reprocessing facilities. Each of these three reports contains a Section VI, which sets forth applicable radiological instrument performance criteria and calibration requirements. Testing and calibration procedures in this report have been formatted in two parts: IV and V, each divided into three subsections: (1) Power Reactors, (2) Mixed Oxide Fuel Plants, and (3) Fuel Reprocessing Facilities. The three performance criteria subsections directly coincide with the performance criteria sections of the previous reports. These performance criteria sections have been reproduced in this report as Part III with references of "required action" added.

25243 (CONF-761006—35) **Microprocessor-assisted calibration for a remote working level monitor.** McDowell, W.P.; Keefe, D.J.; Groer, P.G.; Witek, R.T. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 8p. Dep. NTIS $3.50.

From Nuclear science, scintillation and semiconductor counter symposium; New Orleans, Louisiana, United States of America (USA) (20 Oct 1976).

A method is described for calibrating a Remote Working Level Monitor, an instrument which measures Working Level and Rn-daughter concentrations in the atmosphere. The method makes use of a microprocessor to calculate beta efficiencies for RaB and RaC from the counts accumulated in the RaA, Ra(B + C) and RaC' channels of the instrument. Both the alpha spectroscopic and total-alpha methods are used to determine the Rn-daughter concentrations. These methods require the processor to solve systems of linear equations with several unknowns. No assumptions about Rn-daughter equilibrium are made.

25244 Radiation detector with a network of convex photoemissive cathodes. Berninger, W.H. (to General Electric Co.). German(FRG) Patent 2,271,584/A/. 15 May 1975. 41p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 15 May 1974, US.

The invention deals with a gamma camera used in nuclear medicine. Description is given of a detector having a good linearity between the output signals of the photocells and the actual position of the scintillation event, whatever may be the spacing between the scintillator and the plane of the photoemissive cathodes. That detector comprises a collimator, a scintillator, a network of photocells, the nonplanar photoemissive cathodes of which, geometrically connected, are mounted in the vicinity of an output end of said scintillator, and an electronic circuit for resolving the photocell output signals representing the position-coordinates of the various light-pulses generated.

25245 Digital technique for neutron-gamma pulse shape discrimination. Morris, C.L. (Virginia Univ., Charlottesville (USA)); Bolger, J.E.; Hoffmann, G.W.; Moore, C.F.; Smith, L.E. (Texas Univ., Austin (USA)); Thiessen, H.A. (Los Alamos Scientific Lab., N.Mex. (USA)). *Nucl. Instrum. Methods;* **137**: No. 2, 397-398(1 Sep 1976).

A technique employing integrating analog-to-digital converters to do pulse shape discrimination between neutron and gamma initiated scintillations in liquid scintillators is described. The technique involves a direct comparison of the fast and slow components of the light output from the scintillator.

RADIATION DOSEMETERS

REFER ALSO TO CITATION(S) 24646

25246 (COO—1671-68) **Track structure theory in radiobiology and in radiation detection.** Katz, R. (Nebraska Univ., Lincoln (USA)). 1976. Contract E(11-1)-1671. 63p. (CONF-760964—3). Dep. NTIS $4.50.

From 9. international conference on solid state nuclear track detectors; Neuherberg/Munchen, German, Federal Republic of (F.R. Germany) (30 Sep 1976).

The response of biological cells, and many physical radiation and track detectors to ionizing radiations, and to energetic heavily

ionizing particles results from the secondary and higher generation electrons ejected from the atoms and molecules of the detector by the incident primary radiation. The theory uses a calculation of the radial distribution of local dose deposited by secondary electrons (delta-rays) from an energetic heavy ion as a transfer function, relating the dose-response relation measured (or postulated) for a particular detector in a uniform radiation field (gamma-rays) to obtain the radial distribution in response about the ion's path, and thus the structure of the track of a particle. The models which have been used for detector response arise from target theory, and are of the form of statistical models called multi-hit or multi-target detectors. Recent work has demonstrated that many-hit physical detectors do exist. From both emulsion sensitometry and from the structure of tracks of heavy ions, it has been shown that emulsion-developer combinations exist which yield many-hit responses. There is also some evidence that the supralinearity in thermoluminescent dosimeters arises from a mixture of 1-hit and 2-hit responses. These detectors can be expected to mimic the response of biological cells to radiations of different quality. Their patterns of response may helpto understand better the structure of particle tracks in SSNTD's.

25247 Evaluation of the fast neutron dose equivalent using the thermal neutron response of LiF TL material. Hankins, D.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Health Phys.;* **31**: No. 2, 170-173(Aug 1976).

A study has been carried out to ascertain the accuracy with which the thermal neutron response of lithium fluoride (normal lithium) can be related to total neutron dose. Surveys were made of the thermal-to-fast neutron ratio at several facilities of the Lawrence Livermore Laboratory and with neutron sources at the low-scatter facility which indicated that the thermal dose could probably be used to evaluate a person's total neutron exposure if the proper calibration factor could be applied. The procedure used to determine this calibration factor is explained and a curve showing the calibration factor for normal lithium TLDs as a function of the % of the total neutron dose that is delivered by incident thermal neutrons given. It has been found that using this procedure to evaluate personnel exposure has in most cases been satisfactory.

NUCLEAR SPECTROSCOPIC INSTRUMENTATION

REFER ALSO TO CITATION(S) 25243

25248 (ANL—76-90, pp 415-420) **Ionization chamber with fast timing properties and good energy resolution for fission fragment detection.** Budtz—Joergensen, C.; Knitter, H.H. (Central Bureau for Nuclear Measurements, Geel, Belg.). 1976.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

In Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-238, and Pu-239.

A twin ionization chamber for fission fragment detection is described. The chamber allows to extract both, fast timing- and energy proportional signals. A time resolution of 1.62 ns FWHM was obtained between two fission fragments detected in the two halves of the chamber. For ^{241}Am α-particles the chamber gave an energy resolution of 1.3 percent. As counting gas methane NTP was used.

25249 (CONF-761006—37) **Intrinsic efficiency of germanium: a basis for calculating expected detector efficiency.** Strauss, M.G.; Sherman, I.S.; Cattelino, M.J.; Brenner, R.; Pehl, R.H. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 7p. Dep. NTIS $3.50.

From Nuclear science, scintillation and semiconductor counter symposium; New Orleans, Louisiana, United States of America (USA) (20 Oct 1976).

A method is presented whereby the intrinsic efficiency of Ge is utilized to calculate the expected peak efficiency of detectors having a wide range of sizes. The intrinsic efficiency of Ge, which is the probability for total absorption, was measured at 122 and 136 keV in Ge(Li) coaxial detectors and HPGe planar detectors having an effective thickness ranging from 5 to 50 mm. At 136 keV it is 64% for a thickness of 10 mm and 82% for 20 mm, after which it levels off reaching 89% at 50 mm. It is shown that the peak efficiency of a detector is a product of only the intrinsic efficiency and the solid angle, once losses due to edge escape and detector imperfections (surface channels and high dislocation densities) are determined. The absolute and relative [to NaI(Tl)] peak efficiency of a sample detector, calculated on the basis of intrinsic efficiency, are in good agreement with measured values. This method should find applications in the design of new detector systems particularly those for diagnostic imaging with ^{99}Tc (140 keV).

25250 Computing gamma spectrometer (Oct 1976) (Engineering Materials). (California Univ., Livermore (USA). Lawrence Livermore Lab.). (CAPE—2540).

206 drawings.

Drawings are given for a 256-channel battery-powered pulse-height analyzer system having a second-generation analyzer with advanced features, lighter weight, and more rugged construction. The 17-kg analyzer includes a NaI detector and is packaged as a small suitcase; it has high stability and accuracy to allow use over the temperature range from -30 to +70°C. The waterproof unit has many features not found on any commercial unit to allow sophisticated analysis by non-electronics oriented personnel. Its 36-button keyboard will allow manipulation of multiple spectra, integrations, and expanded energy scale with readout in keV. If its self-contained SX70 display camera is not sufficient for record keeping, the unit will telemeter all data onto analog tape or send to a remote computer via phone coupler.

25251 Crystals for astronomical X-ray spectroscopy. Burek, A. (Los Alamos Scientific Lab., N.Mex. (USA)). *Space Sci. Instrum.;* **2**: No. 1-3, 53-104(Aug 1976).

From Symposium on the techniques of solar and cosmic X-ray spectroscopy; Holmbury, U.K. (22 May 1975).

100 refs.

Crystal spectrometric properties and the factors that affect their measurement are discussed. Theoretical and experimental results on KAP are summarized and theoretical results based on the dynamical theory of X-ray diffraction are given for the acid phthalates as well as for the commonly used planes of ADP, PET and EDDT. Anomalous dispersion is found to be important for understanding the details of crystal Bragg reflection properties at long X-ray wavelengths and some important effects are pointed out. The theory of anomalous dispersion is applied to explain the anomalous reflectivity exhibited by KAP at 23.3A.

HIGH ENERGY PHYSICS INSTRUMENTATION

REFER ALSO TO CITATION(S) 25511

25252 Test of lead/liquid argon electromagnetic shower detector. Hitlin, D.; Martin, J.F.; Morehouse, C.C. (Stanford Linear Accelerator Center, Calif. (USA)); Abrams, G.S.; Briggs, D.; Carithers, W.; Cooper, S.; Devoe, R.; Friedberg, C.; Marsh, D. *Nucl. Instrum. Methods;* **137**: No. 2, 225-234(1 Sep 1976).

The design and construction of two lead/liquid argon electromagnetic shower detectors are described. Test results in beams of electrons and πp of momenta 0.125-4 GeV/c and 1-4 GeV/c respectively are presented. Measurements were made of the energy resolution for electromagnetic showers, the position resolution, the behavior of the device in a transverse magnetic field and the radial and longitudinal characteristics of energy deposition, especially as they apply to $\pi p/e^-$ discrimination.

RADIOMETRIC INSTRUMENTS

REFER ALSO TO CITATION(S) 25259

25253 (DP—1439) **Microcomputer-based pneumatic controller for neutron activation analysis.** Byrd, J.S.; Sand, R.J. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Oct 1976. Contract E(07-2)-1. 140p. Dep. NTIS $6.00.

A microcomputer-based pneumatic controller for neutron activation analysis was designed and built at the Savannah River Laboratory for analysis of large numbers of geologic samples for locating potential supplies of uranium ore for the National Uranium Resource Evaluation program. In this system, commercially available microcomputer logic modules are used to transport sample capsules through a network of pressurized air lines. The logic modules are interfaced to pneumatic valves, solenoids, and photo-optical detectors. The system operates from programs stored in firmware (permanent software). It also commands a minicomputer and a hard-wired pulse height analyzer for data collection and bookkeeping tasks. The advantage of the system is that major system changes can be implemented in the firmware with no hardware changes. This report describes the hardware, firmware, and software for the electronics system.

RADIATION EFFECTS ON INSTRUMENT COMPONENTS, INSTRUMENTS, OR ELECTRONIC SYSTEMS

25254 (PEM—54) **Nuclear EMP: protection from an EMP-line surge on a wideband signal line.** Faraudo, B.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1976. Contract W-7405-ENG-48. 10p. Dep. NTIS $3.50.

A spark gap assembly was developed to protect wide band equipment from improper operation or damage due to fast, high voltage transients that may occur on the coaxial signal cable feeding

the equipment. It consists of a commercial fixed, sealed gap mounted in a modified General Radio coaxial tee fitting of either 100 ohms or 50 ohms characteristic impedance. The gaps are presently available from one manufacturer and in voltage breakdown ratings from 350 to 3500 vdc.

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 24107, 24416, 24421, 24460, 24615, 24685, 25123, 25275, 25713

25255 (LA—6605-M) **Fast-response CAMAC crate controller.** Seeger, P.A. (Los Alamos Scientific Lab., N.Mex. (USA)). Dec 1976. Contract W-7405-ENG-36. 32p. Dep. NTIS $4.00.

The requirement to acquire data at high rates at the Weapons Neutron Research (WNR) facility, while maintaining transportability of experimental hardware through the use of CAMAC, has led to the development of a fast-response CAMAC crate controller. Speed is attained by minimizing computer overhead three ways: by programmable stored sequences of CAMAC instructions in the controller, by hardware implementation of CAMAC "Q-modes," and by use of direct-memory access to the computer memory. The device is interfaced to a MODCOMP-IV. The circuit is described fully, and software examples are given.

25256 (LBL—5725) **Laser velocimeter with high spatial resolution.** Chew, C.T. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1976. Contract W-7405-ENG-48. 146p. Dep. NTIS $6.00.

Thesis.

Aspects to be considered in the design of a laser Doppler velocimeter have been studied in detail. These aspects were applied to the construction of a velocimeter capable of high spatial resolution and accurate scanning. Moreover the device operates interchangeably both in the reference and differential modes, thus giving the three velocity components at any selected point of measurement. Experiments have been performed with the velocimeter to test its reliability in velocity measurements. These tests have been carried out using a rotating disk and scaled down flow channel.

25257 **Theory of measurement of aerosol size distributions of single and multiple cascade impactors. I. A mathematical description of the cascade impactor.** Berner, A. (Vienna Univ. (Austria). 1. Physikalisches Inst.). *Staub-Reinhalt. Luft;* **36**: No. 9, 385-390(Sep 1976). (In German).

2 figs.; 10 refs.

First, the mathematical aspects of measuring size distributions by impactors are considered, followed by a discussion of the impactor calibration. The calibration is based on the separation characteristics of the impactor stages, without respect of the aerosol properties. Finally the multiple impactor is introduced. This impactor is made up from several single impactors. In the limit of infinite many impactors, the multiple impactor delivers a continuous size distribution.

25258 **Design and performance of a microwave strain measuring system for materials tests.** Billeter, T.R.; Blackburn, L.D. (Westinghouse Hanford Co., Richland, WA). *Nucl. Technol.;* **31**: No. 2, 264-275(Nov 1976).

Excellent sensitivity and accuracy in the measurement of deformation occurring in materials tests were achieved with a newly developed microwave frequency sensor and instrumentation system. The strain sensor comprises a microwave cavity resonating in the circular TE113 and TM110 modes. Detection of axial strain occurs due to the changes of resonant frequency incurred by cavity length changes. Axial strain sensitivity for the TE113 mode was 6×10^{-6} per MHz, whereas radial dimensions of the cavity were related to frequency of the TM110 mode. Aperture coupling of the cavity to the end wall of K/sub a/ band waveguide provided signal excitation of the two monitored modes. Phase-locked frequency stability enabled digital count/display of resonant frequencies to within 70 kHz at 35 GHz. Room temperature tension test results demonstrated a strain measuring sensitivity ($+-1 \times 10^{-6}$) and accuracy (+-1 percent of the measured value) equivalent to those of electrical resistance strain gauges. The system yields accurate measurements of elastic strains as well as small departures from elastic response and hysteresis behavior during unloading and reloading. Creep test results confirm that measurement sensitivity and accuracy are retained in elevated temperature tests. Strain response on loading, subsequent creep deformation, and creep recovery after unloading can all be measured in detail. The stability of microwave sensor calibration after exposure for 22×10^6 s at temperatures from 728 to 866 K is shown to be excellent.

WELL LOGGING INSTRUMENTATION

REFER ALSO TO CITATION(S) 23964, 23993, 24003, 24052

25259 **Method and device for well-logging through thermal neutrons.** Arnold, D.M.; Paap, H.J.; Pitts, R.W. Jr. (to Texaco Development Corp.). French Patent 2,279,119/A/. 16 Jul 1975. 38p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 17 Jul 1974, US.

A bore-hole goes through sub-soil formations and is tubed by means of a tubing maintained in position by a concrete layer. A well logging probe is suspended in that bore-hole by a cable. The latter provides the connection between the equipments mounted in the probe and the ground-level equipments.

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

25260 (LA—6250) **MES code: chemical-equilibrium detonation-product states of condensed explosives.** Fickett, W. (Los Alamos Scientific Lab., N.Mex. (USA)). Dec 1976. Contract W-7405-ENG-36. 127p. Dep. NTIS $6.00.

The MES code calculates states of the reaction products of detonation in gaseous or condensed explosives under the assumption of thermal and chemical equilibrium. The products may consist of any number of gaseous species and one solid species. The condition of equilibrium includes the number of phases: the solid may or may not be present depending on the current state. In addition to the primary calculation of the Chapman-Jouguet state at a specified set of initial densities, the detonation Hugoniot, and contours of constant temperature, density, energy, or entropy, each at a specified set of pressures may be obtained. All of the first derivatives (e.g., sound speed and heat capacity) are calculated at each point. The solid equation of state is one constructed from a given shock Hugoniot under the assumption of constant Gruneisen coefficient. For the gas, either the ideal gas, the Kistiakowsky-Wilson, or the LJD (Lennard-Jones-Devonshire cell theory) equation of state may be used. Several choices of "mixture rules" for extending the last one, a pure-fluid equation of state, to mixtures are offered. For LJD, the input data are the parameters defining the intermolecular potentials of the species.

25261 (LA—6454) **Accuracy of the conventional Lagrangian scheme for one-dimensional hydrodynamics.** Fickett, W. (Los Alamos Scientific Lab., N.Mex. (USA)). Nov 1976. Contract W-7405-ENG-36. 163p. Dep. NTIS $6.75.

The accuracy of the conventional Lagrangian scheme for one-dimensional hydrodynamics is assessed by detailed comparison with a variety of test problems having exact solutions. The choice of test problems is made in the context of wave motions in the pressure range of detonations in condensed explosives. For each test problem the calculation is made for 16, 32, 64, 128, and 256 computation cells. The results and the exact solution are compared along particle and shock paths by superposing a plot of the exact solution on a plot of the calculated result. Also, the integrated errors over a typical time span are plotted against the reciprocal number of cells. The effect of changing such parameters of the computational method as the form and amount of artificial viscosity is investigated. For these relatively simple geometries, accuracy better than that found for typical experimental geometries can be achieved with 100 or 200 cells and a CDC 7600 computer time of a minute or two.

25262 (LA—6598-PR) **Feasibility of using Amatex in Air Force submunitions. Progress report, December 1, 1974—March 21, 1976.** Popolato, A.; Lederman, G.F. (Los Alamos Scientific Lab., N.Mex. (USA)). Nov 1976. Contract W-7405-ENG-36;AFAL-PO-5-0650-176;AFAL-PO-ATL-6-0056. 27p. (AFATL-TR—76-112). Dep. NTIS $4.00.

Flash radiography was used to determine fragment velocity as a function of explosive fill, booster size, and temperature for BLU-61A/B and BLU-63/B submunitions. A simple method for the total recovery of fragments was developed. This method was used to obtain quantitative fragmentation data. Compared with their preferred fills, the fragment velocity was about 12 percent less for Amatex/30-filled submunitions initiated with oversized boosters. The total number of fragments generated was reduced about 10 percent. No problems were encountered with the preparation of Amatex. Riser scrap was recycled after storage at 40 percent relative humidity with no significant change in melt viscosity.

25263 (MHSMP—76-45) **Quarterly progress report, July—September 1976.** (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1976. Contract DA11173-AMC-487A. 29p. Dep. NTIS $4.00.

Tests were conducted to evaluate the reactivity of RX-03-BB, two epoxy samples (ABV-23 and ABV-24), Scotchcast No. 225, Fluorocarbon FC-40 and a 50/50 mixture of Scotchcast and Fluoro-

carbon. The epoxy samples were more reactive than the others. A coupon test series was begun to establish baseline information about the relationship between the reactivity screening tests and the degree of reactivity that exists between RX-03-BB and other materials. Chemical reactivity tests were run on six lots of TATB from Cordova and one lot from United Technologies Corp. No differences were observed in these seven samples. An analysis was made on a sample of PETN conditioned 225 days at 353°K. A series of tests is planned to determine the effect of several parameters on the decomposition rate of PETN at 393°K. Tests were conducted which show the repeatability of the Model 1800 Varian gas chromatographs in both isothermal and programmed modes. A 50/50 mixture of N_2 and CO_2 was used and the ratio of the peak areas and the calibration constants were compared. The relative standard deviation of the ratio of the peak area was 0.3% and the calibration constant varied from 0.6 to 1.4%.

25264 (MHSMP—76-46C) **TATB/Kel-F: PBX analysis.** Schaffer, C.L. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1976. Contract DA11173-AMC-487A. 7p. Dep. NTIS $3.50.

The analysis of RX-03-BB is complicated by the characteristics of triaminotrinitrobenzene (TATB). Some of these characteristics are: TATB is insoluble in most organic solvents; solvents for the Kel-F are also solvents for the impurities in the TATB; the various particle sizes of the TATB and the TATB coated by the Kel-F are difficult to extract from the Kel-F. Three methods have been used to obtain the analysis. These are reported as the methyl isobutyl ketone (MIBK), the nitric acid and the sulfuric methods. The analytical methods evaluated for RX-03-BB are discussed and the advantages and disadvantages of each method are listed.

25265 (MHSMP—76-46D) **TATB PBX development low percent binder survey. Progress report, July—September 1976.** Osborn, A.G.; Stallings, T.L. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1976. Contract DA11173-AMC-487A. 11p. Dep. NTIS $3.50.

A preliminary survey of nine plastic binders with TATB, screened by the indirect tensile test, indicates that Kel-F 800 is the most promising candidate to be considered as a low percent binder for TATB.

25266 (SAND—76-0373) **Calculation of performance parameters of an electroexplosive device using digital data techniques.** Strasburg, A.C. (Sandia Labs., Albuquerque, N.Mex. (USA)). Dec 1976. Contract E(29-1)-789. 45p. Dep. NTIS $4.00.

Procedures have been developed to calculate performance parameters from input and output responses generated by an electroexplosive device subjected to a functional test. The data system assembly consists largely of commercially available hardware. The basic concepts can be implemented in varying degrees of sophistication with other types and models of equipment. The system and programs, including predecessor programs, has been used successfully for two years. Operating experience to-date indicates that a data system of this type is a most versatile tool for use in an explosive component testing facility.

25267 **Brightness temperature of detonation wave in liquid explosives.** Urtiew, P.A. (Univ. of California, Livermore). *Acta Astronaut.;* 3: 555-566(1976).

An optical technique for measuring thermal radiation off hot surfaces has been used to measure the brightness temperatures of the detonation waves in some liquid explosives. Nitromethane, tetranitromethane, and hydrazine—hydrazine-nitrate solutions have been used as the testing liquids. Comparison of our nitromethane data with data reported in the literature reveals good agreement. This good agreement leads us to the conclusion that this technique may be applicable to other, more sophisticated, explosives for which experimental data are not available. The possible effect of the nonuniform structure of the wave is discussed, and an estimate is made of the error that may result from the nonuniform distribution of temperature.

NUCLEAR

REFER ALSO TO CITATION(S) 25587

25268 (UCRL—78375) **Comparison of the inelastic response of steel building frames to strong earthquake and underground nuclear explosion ground motion.** Murray, R.C.; Tokarz, F.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Jun 1976. Contract W-7405-ENG-48. 4p. (CONF-770103—6). Dep. NTIS $3.50.

From 6. world earthquake conference; New Delhi, India (10 Jan 1977).

Analytic studies were made of the adequacy of simulating earthquake effects at the Nevada Test Site for structural testing purposes. It is concluded that underground nuclear explosion ground motion will produce inelastic behavior and damage comparable to that produced by strong earthquakes. The generally longer duration of earthquakes compared with underground nuclear explosions does not appear to significantly affect the structural behavior of the building frames considered. A comparison of maximum ductility ratios, maximum story drifts, and maximum displacement indicate similar structural behavior for both types of ground motion. Low yield (10 - kt) underground nuclear explosions are capable of producing inelastic behavior in large structures. Ground motion produced by underground nuclear explosions can produce inelastic earthquake-like effects in large structures and could be used for testing large structures in the inelastic response regime. The Nevada Test Site is a feasible earthquake simulator for testing large structures.

CIVIL USES

REFER ALSO TO CITATION(S) 24037

WEAPONRY

REFER ALSO TO CITATION(S) 25169, 25255

25269 (LA—6261-M) **YAQUI user's manual for fireball calculations.** Norton, J.L.; Ruppel, H.M. (Los Alamos Scientific Lab., N.Mex. (USA)). Dec 1976. Contract W-7405-ENG-36. 297p. Dep. NTIS $9.25.

Recent modifications and additions made to the YAQUI code are described. This code, which was written to simulate nuclear explosions in the atmosphere, has been improved to include the effects of turbulence. In addition, it now allows input data to be obtained by direct interpolation in the one-dimensional results of early time radiation codes. This new version also makes most of the input free-format (namelist) and is composed of modules for easier modification and isolation of computer system dependence.

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

REFER ALSO TO CITATION(S) 24876

BASIC STUDIES

REFER ALSO TO CITATION(S) 25141, 25224, 25494

25270 (ANL/ES—40(Vol.8)) **Environmental status of the Lake Michigan region. Volume 8. Atmospheric environment of the Lake Michigan drainage basin.** Gatz, D.F.; Changnon, S.A. Jr. (Argonne National Lab., Ill. (USA)). Nov 1976. Contract W-31-109-ENG-38. 166p. Dep. NTIS $6.75.

Climate was the most important factor in producing the Great Lakes we have today. Through glacial action during the Pleistocene Epoch, the surface topography, shape, and depth of Lake Michigan were determined. Today the Lake Michigan region has a humid, continental climate. Summers are hot and humid, and winters are cold and stormy. Lake Michigan, as a reservoir for storing and exchanging heat, is a moderating influence on extreme temperatures. The Lake is also a moisture source, especially during late fall and early winter when Arctic air flows over the still-warm lake. Heavy snows in the lee of the Lake can result. Regional atmospheric dispersion conditions are generally good in locations away from the Lake. Air mass stagnation conditions are expected only four times a year, and three of these should last no longer than two days each. However, over and near the Lake, conditions can be extremely different. During the warm season, when the air over the Lake is relatively cold and stable, onshore airflow can produce a number of conditions leading to high pollutant concentrations within 10 km of the Lake shore. The pollutants also have effects on the weather, including reduced visibility and solar radiation, and increased cloudiness. They may also play a role in producing excess precipitation downwind of large industrial and population centers. Atmospheric pollution also provides an important pathway for the transfer of pollutants deposited on the Lake surface both by dry fallout and in precipitation.

25271 (BNL—21946) **Limitation on electrical measures of aerosols.** Marlow, W.H. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract EY-76-C-02-0016. 12p. (CONF-760985—1). Dep. NTIS $3.50.

From 8. materials research symposium; Gaithersburg, Maryland, United States of America (USA) (20 Sep 1976).

Based upon the assumption that there is a constant, natural, background ion source, atmospheric conductivity has been used as a measure of the presence of aerosol particles because such particles remove the effective charge carriers from the atmosphere. Another variety of electrical measure is the total charge acquired by the aerosol under either natural or artificial charging conditions. Currently, the most widely cited electrical method for aerosol size distribution analysis is the diffusion charging mobility analysis method in which the electrical current due to the controlled unipolar charging of the aerosol is measured while increasing mobility fractions of that aerosol are removed. The hypothesis is that by monitoring the diminution of aerosol current as a function of the known particle electrical mobilities removed, a measure of the aerosol size distribution is derived. Fundamental to all such measures of aerosol size is the assumption that any aerosol can be put in a well-defined charge state. This note presents an examination of that assumption.

25272 (EPA—600/1-76-006) **National environmental specimen bank survey.** Van Hook, R.I.; Huber, E.E. (Oak Ridge National Lab., Tenn. (USA)). Jan 1976. Contract W-7405-eng-26;EPA-IAG-D4-0509-PRJ-IAA005. 217p. Dep. NTIS $7.75.

This report presents the data base developed in the National Environmental Specimen Bank (NESB) Survey. The methodology utilized in developing the mailing lists and in developing and maintaining the data base records also is included. The NESB Survey Data Base is computerized in the Oak Ridge Computerized Hierarchical Information System, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830. The NESB Survey mailing list consisted of 4500 names and addresses. The 657 environmental specimen collections that were located and documented in the NESB Survey Data Base include the following categories: animal, atmospheric, geological, microbiological, plant, and water. However, the majority of the collections identified are biological in nature. Three indices of the NESB Survey Data Base are included in this report: respondents names and addresses categorized by organizational affiliation; (2) alphabetical listing of respondents; and geographical sampling location for materials in collections.

25273 (ORNL-tr—4230) **Method for determining atmospheric dispersion conditions from synoptic observations.** Klug, W. Translated by R.G. Mansfield from *Staub-Reinhalt. Luft;* **29**: No. 4, 143-147(Apr 1969). 13p. Dep. NTIS $3.50.

Measures taken in the area of maintenance of pure air frequently require knowledge of the climatological distribution of atmospheric dispersion conditions in a certain locality. This applies, among other things, to the method for determining the minimum height of stacks, which at present is under discussion for the preparation of a new VDI guideline. A climatological distribution of the dispersion conditions would be relatively easily obtained if long-term measurements of turbulence were available for the locality at which the distribution is needed. Such turbulence measurements, however, have been made at only a few places and then only as spot checks. For this reason, a correlation between easily obtainable meteorological data and atmospheric dispersion conditions is of considerable practical importance. The most useful would be one which permits making conclusions as to atmospheric dispersion conditions from the data of a synoptic observation. The correlation scheme should also be objectively programmable and hence programmable for data-processing installations. That such a correlation scheme is also applicable to the calculation of actual concentration fields is obvious.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 25124, 25257, 25270, 25293, 25294, 25296, 25297, 25308

25274 (ANL—76-XX-22) **Urban design and public exposure to carbon monoxide.** Santini, D.J. (Argonne National Lab., Ill. (USA)). Oct 1976. Contract W-31-109-ENG-38;NSF-AG-352;GI-32989A2. 10p. Dep. NTIS $3.50.

The air pollutant carbon monoxide (CO) is produced by incomplete combustion in motor vehicles, space heating, industrial processes, and incineration. Current research indicates that higher density residential developments, because they lead to reduced demand for fuels for home heating and transportation, tend to lower total carbon monoxide emissions. However, it is in these same areas that concentrations of CO are the highest because of the density of emitters. Since carbon monoxide standards specify maximum allowable concentrations rather than emissions, they tend to deter further development in locations where concentrations are already high - i.e., high density downtown areas. This deterrent effect contributes to greater total emissions of carbon monoxide; hence, it may be desirable to devise a means of controlling the public's risk of exposure to high CO levels in downtown areas without deterring new center city residential development. In protecting the public from the risk of exposure to damaging levels of carbon monoxide, two approaches are possible; the pollutant's concentration may be lowered by traffic management measures or the public's rate of exposure may be reduced through urban design features. The present emphasis on traffic management stresses improving the flow and reducing the level of traffic, goals that are extremely costly to achieve in downtown areas. This paper examines ways to reduce risk of exposure by the physical design of new downtown residential developments. The concept is not a novel one, having been successfully implemented in industry to provide occupational health and safety.

25275 (BERC/RI—76/9) **Quality-control gas-detector tube readers: optical versus observer.** Carroll, H.B. Jr. (Energy Research and Development Administration, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Dec 1976. 45p. Dep. NTIS $4.00.

The influence of temperature and humidity upon two length-of-stain gas detector tube systems was studied. Length-of-stain tubes were exposed under carefully controlled laboratory conditions, then read by a panel of observers and a newly developed optical tube reader. Data from the study show, generally, good correlation of results between the observer panel and the optical tube reader. Also, the data indicated that temperature and humidity calibration curves or tables were needed for several of the detector tubes. The two detector tube systems were comparable in reliability; however, for detecting a particular gas, one system may be selected over the other.

25276 (BNWL-SA—5931) **Comprehensive aerosol growth model.** Drake, R.L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 2 Aug 1976. Contract E(45-1)-1830. 6p. (CONF-761202—2). Dep. NTIS $3.50.

From Topical meeting of the Optical Society of America; Williamsburg, Virginia, United States of America (USA) (13 Dec 1976).

The paper describes the aerosol component of a user-oriented computer code that was formulated to solve the general equations of continuity for trace substances in the atmosphere.

25277 (CONF-761121—2) **Plant-pollutant interactions and The Oak Ridge approach to air-pollutant impact analysis.** McLaughlin, S.B.; Shriner, D.S. (Oak Ridge National Lab., Tenn. (USA)). 1976. Contract W-7405-ENG-26. 23p. Dep. NTIS $3.50.

From Forest and fire meteorology conference; St. Louis, Missouri, United States of America (USA) (16 Nov 1976).

The processes by which pollutants move from the atmosphere to sites of action within plant cells are influenced by a wide variety of physical, chemical and biological factors. Of major importance among these are the physical and chemical form of the pollutants, the kinetics of the pollutant exposure regime, the solubility of pollutants in cell systems, and their biological reactivity. The impact of a given dose on plant response is mediated by the above factors as well as many plant-related variables. Present needs in air pollution research relative to interactions of these factors are discussed with special emphasis on chronic impacts of potential regional scale significance. Current air pollution research at Oak Ridge includes both process level studies dealing with the impact of pollutants on plant physiology and growth, and regional scale studies designed to consider pollutant transport and effects on forest systems. In process-level studies major emphasis is being placed on the effects of individual and combined exposures with SO_2, ozone, and acid precipitation. In addition, the effects of a variety of organic effluents of potential importance in developing coal conversion technologies are being studied. Studies related to regional environmental problems are being initiated to consider air pollution effects on forest systems over large temporal and spatial scales. These studies will rely heavily on air transport models to describe pollutant distribution and forest growth models to describe probable long-term impacts of pollutants on forest growth and composition.

25278 (COO—2874-3) **Maxima of partial samples in Gaussian sequences. Technical report No. 3.** Mittal, Y. (Stanford Univ., Calif. (USA). Dept. of Statistics). 1 Aug 1976. Contract EY-76-S-02-2874. 25p. Dep. NTIS $3.50.

The problem arose from some practical considerations of collecting air pollution data. Air pollution standards are generally in terms of the maximum concentrations. Various practical difficulties (cost of sampling or missing data) are at times responsible for having only a partial sample available for making inferences. The behavior of the difference of two maxima considered here can thus be used to retract information about the original maximum via the maximum of only a partial sample.

25279 (COO—2874-4) **Robustness of linear estimators to misspecification of trend. Technical report No. 4.** Sheshinski, R. (Stanford Univ., Calif. (USA). Dept. of Statistics). 16 Aug 1976. Contract EY-76-S-02-2874. 28p. Dep. NTIS $4.00.

The following work is a continuation of an earlier report, Sheshinski (1976). In this paper we continue our examination of the problem of interpolation of air pollution concentrations over an air

basin, using a model of a spatially autocorrelated random process. In Chapter I we compare estimators based on a correctly and incorrectly specified constant mean with estimators based on an unspecified constant mean. In Chapter II we compare estimation done with a specified linear trend function to estimation with an unspecified linear trend function. The third chapter deals with a biased partially constrained estimator versus a fully constrained universally unbiased estimator in the presence of a linear trend.

25280 (COO—2874-6) **Analysis of air pollution data in Kawasaki City, Japan.** Washio, Y. (Keio Univ., Tokyo (Japan); Stanford Univ., Calif. (USA)). 17 Sep 1976. Contract EY-76-S-02-2874. 20p. Dep. NTIS $3.50.

Air pollution monitoring activities at Kawasaki City, Japan during 1969 through 1974 are discussed. Data are presented on sulfur oxides, nitrogen oxides, CO, and suspended particulates in relation to weather conditions.

25281 (COO—2874-10) **Shelf list of reports on air pollution and health filed in the Girshick Library, Stanford University. Working paper No. 4.** Hole, B. (Stanford Univ., Calif. (USA)). 25 Oct 1976. Contract EY-76-S-02-2874. 15p. Dep. NTIS $3.50.

A list of reports on air pollution and health on file at the Girshich Library at Stanford University is presented. (ERB)

25282 (COO—2874-11) **Interpolation of air pollution: a stochastic approach.** Faith, R. (Stanford Univ., Calif. (USA)). 1 Nov 1976. Contract EY-76-S-02-2874. 8p. Dep. NTIS $3.50.

In epidemiological studies of the effects of air pollution it is desirable to obtain estimates of the exposure to various pollutants of persons living throughout a geographical region under study. On the other hand, it is typically the case that pollution levels are measured at only a few locations. The problems of interpolating these values and of determining the accuracy of interpolation are amenable to analysis by way of spatial stochastic models. Such models can lead to an optimal interpolation technique, in a manner which is reviewed here. The method requires for its application knowledge of the spatial convariance structure of the pollutant to which it is applied. Some difficulties encountered in estimating this for oxidant levels in the San Francisco Bay Area are mentioned.

25283 (DP-MS—76-25) **Smoke dispersal from a controlled fire in logging debris over a cleared pine forest area.** Murphy, C.E. Jr.; Sigmon, J.T.; Williams, D.T.; Ryan, P.W.; McNab, W.H. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1976. Contract E(07-2)-1. 5p. (CONF-761121—1). Dep. NTIS $3.50.

From Forest and fire meteorology conference; St. Louis, Missouri, United States of America (USA) (16 Nov 1976).

The dispersion of smoke in the atmosphere was studied during a controlled fire of forest debris. An instrumented aircraft measured smoke density and other parameters in multiple traverses through the smoke plume. The data permitted contour maps of constant smoke density to be drawn in three dimensions. Centerline smoke density reached a maximum of 0.43 $\mu g/m^3$. Supporting meteorological data were taken at an array of towers (7 towers, each 62 meters high) near the fire, and at different elevations on a TV tower (400 meters high) located 35 km from the site of the fire. The data will permit the testing of mathematical models for the prediction of the dispersion of pollutants in the atmosphere.

25284 (EPRI-EA—316) **Sulfur oxides: current status of knowledge. Final report.** Colucci, A.V. (Greenfield, Attaway and Tyler, Inc., San Rafael, Calif. (USA)). Dec 1976. 155p. Dep. NTIS $6.75.

The report is a state-of-the-art review on sulfur oxides, including sulfur dioxide, sulfurous and sulfuric acid, sulfates, sulfites, and bisulfites. The report considers the interaction of sulfur oxides with other pollutants that may be associated with health impacts. The major topics of discussion are the toxicological assessment, the human clinical assessment and the epidemiological assessment of sulfur oxide health effects. Special consideration is given to the sulfate-health effects issue. Major emphasis is placed upon the identification of existing gaps in our knowledge, and suggestions are offered for future research programs in the sulfur oxides-health effects area.

25285 (LBL—5213) **Resonance absorption lineshape of NO using a Zeeman tuned Cd lamp: application to combustion.** Hadeishi, T.; Agrawal, Y.; McLaughlin, R.D.; Robben, F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 6 Jan 1976. Contract W-7405-ENG-48. 7p. Dep. NTIS $3.50.

The need for the development of non-interfering, in-situ measurement techniques for the oxides of nitrogen is underlined by the continued discrepancies in measurements reported in the literature. These discrepancies exist in measurements made using different probes and also between probe measurements and optical measurements. Here we describe a technique, first developed in our laboratory for atomic absorption spectroscopy, which is non-interfering, sensitive, and capable of distinguishing between NO and any other absorbing species that might be present. Essentially, resonance excitation of a single rotational level of NO is achieved by Zeeman tuning of an atomic line. We have measured the absorption lineshape and effective collision broadening cross-section for excitation of a single line corresponding to the $\Lambda 2u$, K = 13 transition of the 0-1 vibrational band of NO, using Zeeman scanning of the 2144.38 A CdII line. Some un-calibrated measurements under combustion conditions have also been made.

25286 (LBL—5288) **Investigation of the use of the resonance Raman effect as an environmental monitor.** Chamberlain, O.; Robrish, P.; Rosen, H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1976. Contract W-7405-ENG-48. 63p. Dep. NTIS $4.50.

An essential element in any strategy designed to cope effectively with atmospheric pollution is the development of more sensitive or more convenient methods for determining the concentrations of pollutant gases in ambient air and in emissions from localized sources. One general class of methods for measuring pollutant concentrations makes use of lasers to probe the atmosphere remotely and obtain spectroscopic information about the molecules present in the segment of atmosphere under consideration. In particular, the use of a laser to measure the Raman spectra of molecular constituents remotely seems to offer some promise of being an effective monitor of gaseous pollutants. This scheme, called Raman Lidar, is implemented in a manner analogous to the use of a radar system. A laser transmitter directs a pulsed beam into the atmosphere. By measuring the time between the initial laser pulse and the returning signal, one determines the range of the atmospheric region being monitored. The light coming from this region is spectroscopically analyzed. The Raman spectrum, which is due to transitions between vibrational states of a molecule, is a unique signature for a particular molecular species. Therefore, a measurement of its intensity allows one to determine the concentration of that molecule in the region of interest. Raman Lidar allows one, in principle, to make a three-dimensional map of molecular concentrations in real time with good spatial resolution out to a distance of several kilometers from a fixed transmitter.

25287 (ORNL/EIS—102) **NSF-RANN trace contaminants abstracts.** Harnden, D.S.; Ross, R.H. (eds.). (Oak Ridge National Lab., Tenn. (USA)). Jan 1977. Contract W-7405-ENG-26. 39p. Dep. NTIS $4.00.

Abstracts are included for 50 published articles that discuss the toxic effects of trace amounts of various elements or compounds considered to be environmental pollutants.

25288 (UCRL—50042-76) **High altitude pollution program first annual report.** Luther, F.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Jun 1976. Contract W-7405-ENG-48. 48p. Dep. NTIS $3.00.

Major accomplishments and significant findings for the past year are reported. Work dealt primarily with mathematical modelling of NO/sub x/ and chlorofluoromethane effects on ozone in the stratosphere. (PCS)

25289 (UCRL—52000-76-11, pp 11-16) **Getting the facts about ozone.** Lovill, J.E. Nov 1976.

In Energy and technology review.

The new Satellite Ozone Analysis Center at LLL soon will be assimilating the flood of data provided by a new series of Air Force satellites for facts about ozone. Among other things, we will be producing daily high-resolution global maps of ozone concentration. Correlated with ground observations, these maps will help us to establish the current average ozone level, to check how solar flares, volcanic eruptions, and atmospheric nuclear tests change their level, to detect long-term trends in ozone concentration, and eventually to predict the effects of various forms of atmospheric pollution.

25290 (UCRL—78182) **Measurement of atmospheric ozone by satellite.** Lovill, J.E.; Sullivan, T.J.; Korver, J.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Sep 1976. Contract W-7405-ENG-48. 5p. (CONF-761124—1). Dep. NTIS $3.50.

From 7. conference on aerospace and aeronautical meteorology; Melbourne, Florida, United States of America (USA) (16 Nov 1976).

Ozone is an important atmospheric trace constituent. The depletion of solar radiation between 200 and 300 nm is the result of strong absorption by ozone in the ultraviolet wavelengths. The energy absorbed in this process is the prime source of thermal energy in the stratosphere. For this reason ozone plays an important role in the large-scale motions of the atmosphere. The extent to which the atmospheric ozone may be changed by natural and man-made events has been of considerable concern for many years. In the 1970's there has been an increased urgency to determine the extent to which the ozonosphere is being influenced anthropogenically by aircraft operating in the stratosphere, by fluorocarbons, by atmospheric nuclear weapons tests, and nonanthropogenically by solar proton events and by volcanic effluents. Total ozone data have been

analyzed from the sensors on Nimbus 3 and 4 satellites during the past seven years and our knowledge has been significantly increased in these data void areas of the Southern Hemisphere and oceanic regions of the Northern Hemisphere. A new ozone satellite sensor will be launched in the autumn of 1976 which will continue total ozone observations begun by the Nimbus 3 and 4 sensors. This sensor and the data analysis are discussed.

25291 (ORNL-tr—4234) **Short- and long-term dispersion factors for calculating the environmental burden due to exhaust air streams.** Vogt, K.J.; Geiss, H.; Voelz, E. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Zentralabteilung Strahlenschutz). 1974. Translation by R.G. Mansfield of ZST—198. 43p. Dep. NTIS $4.00.

At the Juelich Nuclear Research Establishment dispersion experiments are being conducted with tagged exhaust air streams for the purpose of determining the diffusion parameters which are necessary for calculations of the environmental burden. The distribution of ground-level concentration is measured with about 100 sampling stations for various weather conditions and different altitudes of emission (50 and 100 m). The results show that the maxima of the ground-level concentration in comparison to the Pasquill prognostics, depending on the diffusion category, are located closer to the source by a factor of 2 to 5, whereby the absolute value of the concentration at the maximum is underestimated by a factor of 2. This discrepancy may be explained by the fact that, in determining the diffusion categories by the method based on synoptic observations, the differing irregularities of the terrain are not taken into consideration. Therefore at Juelich statistical studies are being made in order to determine the relation between the dispersion parameters measured in experiments as well as stability parameters such as, for example, the Richardson number. In addition, studies are being conducted on the determination of the ground roughness parameters. The results are used in calculating the environmental burden from emitters of harmful substances.

25292 **Announcement of the scope of application of the agreement on carrying out a European action in the field of environmental protection on the subject 'Research activities on the physicochemical behaviour of sulfur dioxide in the atmosphere'.** *Bundesgesetzblatt, Teil 2;* No. 41, 1281(Jul 1976). (In German).

Short communication only.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 24083, 24119, 24121, 25243, 25291

25293 (HASL—315) **Health and Safety Laboratory environmental quarterly, September 1, 1976—December 1, 1976.** Hardy, E.P. Jr. (Energy Research and Development Administration, New York (USA). Health and Safety Lab.). 1 Jan 1977. 228p. Dep. NTIS $8.00.

This report presents current data from the HASL environmental programs, The Swedish Defense Research Establishment, The Woods Hole Oceanographic Institution, Argonne National Laboratory and The New Zealand National Radiation Laboratory. The initial section consists of interpretive reports and notes on ground level air radioactivity in Sweden from nuclear explosions, plutonium in air near the Rocky Flats Plant, nitrous oxide concentrations in the stratosphere, lake sediment sampling, plutonium and americium in marine and fresh water biological systems, radium in cat litter, and quality control analyses. Subsequent sections include tabulations of radionuclide and stable lead concentrations in surface air; strontium-90 in deposition, milk, diet, and tapwater; cesium-137 in Chicago foods in October 1976 and environmental radioactivity measurements in New Zealand in 1975. A bibliography of recent publications related to environmental studies is also presented.

25294 (HASL—315(App.)) **Appendix to Health and Safety Laboratory environmental quarterly, September 1, 1976—December 1, 1976.** (Energy Research and Development Administration, New York (USA). Health and Safety Lab.). 1 Jan 1977. 258p. Dep. NTIS $9.00.

Separate abstracts were prepared for three sections of this report.

25295 (HASL—315(App.), pp A.1-A.400) **^{90}Sr and ^{89}Sr in monthly deposition at world land sites.** 1 Jan 1977.

In Appendix to Health and Safety Laboratory environmental quarterly, September 1, 1976—December 1, 1976.

Data are presented on content of ^{90}Sr and ^{89}Sr in samples of precipitation collected during 1976 at 30 monthly monitoring sites in the USA and 75 in other countries.

25296 (HASL—315(App.), pp B.1-B.149) **Radionuclides and lead in surface air.** Feely, H.W.; Toonkel, L.E.; Schonberg, M. 1 Jan 1977.

In Appendix to Health and Safety Laboratory environmental quarterly, September 1, 1976—December 1, 1976.

Data are presented on the content of ^{7}Be, ^{54}Mg, ^{55}Fe, ^{89}Sr, ^{90}Sr, ^{95}Zr, ^{109}Cd, ^{137}Cs, ^{141}Ce, ^{144}Ce, ^{210}Pb, ^{238}Pu and ^{239}Pu and stable Pb in samples of surface air collected from various world locations during 1976.

THERMAL EFFLUENTS MONITORING AND TRANSPORT

25297 (BNWL-SA—5901) **Observed cooling tower plume characteristics.** Wolf, M.A. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jul 1976. Contract E(45-1)-1830. 29p. (CONF-760698—1). Dep. NTIS $4.00.

From AENEC Workshop 1) plume modeling-field data interactions; Oak Ridge, Tennessee, United States of America (USA) (16 Jun 1976).

In-plume measurements with an instrumented Cessna 411 aircraft were made at the Rancho Seco Nuclear Generating Station (913 MWe) near Sacramento, California; the Trojan nuclear plant (1130 MWe) on the Columbia River 50 mi. north of Portland, Oregon; and the coal-fired Centralia Steam Plant (1400 MWe) 50 mi. north of the Trojan plant. Additional surface-based operations conducted at Rancho Seco included pibal tracking to determine the wind velocity profile, time-exposure photographs of the plume for external plume definition and measurements of sulfate deposition due to the drift of entrained circulating water. Heat rejection at Rancho Seco is from two 425 ft. natural-draft towers whose exit diameters are 195 ft; at Trojan, from a single 500 ft. natural-draft tower with exit diameter of 250 ft; and at Centralia, from four mechanical-draft towers. Results of the analyses to date are summarized for three days' operation at Rancho Seco (February 17, 18, and 20 in 1975) and one day (May 13, 1976) at Trojan and Centralia. During the course of these flights, measurements of temperature, humidity, turbulence, Aitken nuclei, and cloud droplet spectra were taken.

25298 (TID—27331) **Chalk Point Cooling Tower Project. Environmental systems corporation's comprehensive project status report for FY75, July 1, 1974—October 1, 1975.** (Environmental Systems Corp., Knoxville, Tenn. (USA)). May 1976. Contract E(11-1)-2381;EPRI-PRJ-RP-256. 135p. Dep. NTIS $6.00.

Results are reported from initial characterization tests on the environmental effects of the natural draft cooling tower of the Chalk Point Unit 3 oil-fired power plant located on the shore of Chesapeake Bay. Data are included on updraft air velocity, plume drift, and sea salt deposition in relation to meteorological conditions.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 24698, 24888

25299 (CONF-750646—3) **Synthetic definition of biological significance.** Buffington, J.D. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-ENG-38. 10p. Dep. NTIS $3.50.

From Workshop on the biological significance of environmental impacts; Ann Arbor, Michigan, USA (4 Jun 1975).

The central theme of the workshop is recounted and the views of the authors are summarized. Areas of broad agreement or disagreement, unifying principles, and research needs are identified. Authors' views are consolidated into concepts that have practical utility for the scientist making impact assessments. The need for decision-makers and managers to be cognizant of the recommendations made herein is discussed. Finally, bringing together the diverse views of the workshop participants, a conceptual definition of biological significance is synthesized.

REGULATIONS

REFER ALSO TO CITATION(S) 24877

ENVIRONMENTAL SCIENCES, TERRESTRIAL

REFER ALSO TO CITATION(S) 24876

BASIC STUDIES

REFER ALSO TO CITATION(S) 25268, 25272

25300 (ORNL/TM—5352) **Land and water resources for environmental research on Oak Ridge Reservation.** Dahlman, R.C.; Kitchings, J.T.; Elwood, J.W. (Oak Ridge National Lab., Tenn. (USA)). Jan 1977. Contract W-7405-ENG-26;E(40-1)-GEN-242. 83p. Dep. NTIS $5.00.

Resources for environmental research on the Oak Ridge Reservation are analogous to the highly complex, physical and engineering facilities of the Oak Ridge National Laboratory. Consequently, land and water resources have been committed to comprehensive research for the purpose of providing relevant, scientific insights on environmental problems associated with ERDA's programs. Diverse aquatic, terrestrial, and agricultural ecosystems are designated for short- and long-term research related to environmental impacts or benefits of different energy technologies. Examples of ecosystems employed in this research include hardwood and pine forests, grasslands and pastures, free-flowing streams and impounded reservoirs, field plots, contaminated environmental natural areas, an array of animal habitats, and calibrated watersheds. Some of the characteristic biota of habitat ecosystems are described in the document. Documentation and planning for use of these lands, waters, and biotic resources also respond to the broad issue of appropriate usage of Federal lands.

25301 **Forest overstory vegetation and environment on the Missouri river floodplain in North Dakota.** Johnson, W.C.; Burgess, R.L.; Keammerer, W.R. (North Dakota State Univ. Fargo). *Ecol. Monogr.;* **46**: No. 1, 59-84(Win 1976).

The study area, bounded north and south by two large reservoirs, includes the most extensive remnant of floodplain forest in the Dakotas. Structure and composition of the forest overstory are strongly related to stand age and horizontal and vertical position on the floodplain. Surface soil environment and species diversity change markedly during the course of succession. The soils of young stands are generally sandy and low in organic matter. Soil nutrient content and available water capacity are generally higher in older stands because of higher organic matter content and repeated inputs of nutrient-rich silt from past floods. Tree species diversity (H') initially increases as stands age, reaches a maximum in stands with mixtures of both pioneer and terminal species, and declines slightly in the oldest stands. Both variety and eveness follow a similar pattern. Analyses of population structure indicate a recent decline in the establishment of small stems of Acer and Ulmus. Tree core analyses show a similar decline in diameter growth rate for Acer, Ulmus, and Fraxinus. Available data suggest that these changes can be attributed to the removal of periodic spring flooding caused by the presence and operation of the reservoirs. It is also hypothesized that the lack of seedling-sapling stands of Populus in the region is the result of a presumed reduction in the meandering rate of the river following reservoir construction and poor seedbed conditions in the absence of flooding.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 25110, 25287

25302 (CONF-760968—1) **Transport model to predict the movement of Pb, Cd, Zn, Cu, and S through a forested watershed.** Munro, J.K. Jr.; Luxmore, R.J.; Begovich, C.L.; Dixon, K.R.; Watson, A.P.; Patterson, M.R.; Jackson, D.R. (Oak Ridge National Lab., Tenn. (USA)). 1976. Contract W-7405-ENG-26. 17p. Dep. NTIS $3.50.

From National conference on disposal of residues on land; St. Louis, Missouri, United States of America (USA) (13 Sep 1976).

Two versions of the Unified Transport Model (UTM) have been used to simulate movement of Pb, Cd, Zn, Cu, and S through the Crooked Creek Watershed, a 1.3 $mi.^2$ forested headwaters area adjacent to a Pb mine and smelter in southeast Missouri. The Wisconsin Hydrologic Transport Model (WHTM) version was used to study accumulation of heavy metals in the soil and to simulate stream flow and heavy metal concentrations in the stream draining the watershed. The Terrestrial Ecology and Hydrology Model (TEHM) version was used to study heavy metal and SO_2 effects on the vegetation by considering plant uptake in a plant growth and decomposition model. The Soil Chemical Exchange of Heavy Metals (SCEHM) submodel in TEHM was used in a detailed comparison between results from a six-year simulation of heavy metal accumulation in the top soil layers and measured values. Agreement between simulated results from both versions of the UTM and measured values is satisfactory.

25303 (TID—27213) **Impact of a lead mining-smelting complex on the forest-floor litter arthropod fauna in the new lead belt region of southeast Missouri.** Watson, A.P. (Kentucky Univ., Lexington (USA)). 1976. Contract E(40-1)-GEN-33. 180p. Dep. NTIS $7.50.

Thesis.

Studies of biological activity within the litter horizons of a watershed contaminated by emissions from a lead-ore processing complex focused on the litter-arthropod food chain as a means of detecting perturbations in a heavy-metal contaminated ecosystem. Both point sources (smelter stack emissions) and fugitive sources (ore-handling processes, yard dusts, and exposed concentrate piles) contributed to the Pb, Zn, Cu, and Cd levels in the study area (Crooked Creek Watershed, Iron County, Missouri, 37°28' N Lat., 91°07' Long). Characterization of arthropod food base and habitat was accomplished by critical examination of litter mass, heavy metal and macronutrient content, cation exchange capacity, and pH. Arthropod trophic level density, biomass, and heavy metal content were determined by analysis of specimens removed from litter by von Tullgren funnel extraction, taxonomically classified, and segregated into the trophic categories of detritivore, fungivore, litter-grazer, omnivore, and predator.

25304 **Uptake of cadmium by soybeans as influenced by soil cation exchange capacity, pH, and available phosphorus.** Miller, J.E.; Hassett, J.J.; Koeppe, D.E. (Univ. of Illinois, Urbana). *J. Environ. Qual.;* **5**: No. 2, 157-160(1976).

The accumulation of cadmium (Cd) and its effect on vegetative growth of soybeans (Glycine max [L.] Merr. var. Amsoy) in soils with a range in cation exchange capacity (CEC), pH, and available phosphorus (P) were investigated in greenhouse experiments. Cadmium uptake decreased as soil pH and CEC increased, while increasing available soil P was related to increased Cd accumulation. Cadmium extracted from the soil by Bray P_1 reagent, Bray P_2 reagent, 2N $MgCl_2$, and 0.1N EDTA was significantly correlated with plant Cd concentrations. The growth of the soybean shoots was generally depressed when tissue concentrations reached 3-5 μg Cd/g dry weight. Cadmium uptake by soybeans was correlated with the ratio of added Cd to the Cd sorptive capacity of soil.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 24119, 25468

TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 25293, 25294, 25335

25305 (COO—2447-5) **Behavior of technetium-99 in soils and plants. Progress report, April 1, 1974—March 31, 1977.** Gast, R.G.; Landa, E.R.; Thorvig, L.J. (Minnesota Univ., St. Paul (USA). Dept. of Soil Science). Dec 1976. Contract EY-76-S-02-2447. 86p. Dep. NTIS $5.00.

Studies described in this report were aimed at establishing the magnitude and mechanisms of ^{99}Tc sorption by soils and uptake by plants. Results show that ^{99}Tc was sorbed from solution over a period of two to five weeks by 8 of 11 soils studied. The slow rate of sorption, the lack of sorption by low organic matter soils, the elimination of sorption following sterilization and increased sorption following addition of dextrose all point to a microbial role in the sorption process. However, it has not been established whether this is a direct or indirect role nor is it possible to clearly predict the conditions under which sorption will occur. Results of plant uptake studies show that ^{99}Tc can be taken up and translocated into the photosynthetic tissue of higher plants with concentrations in seeds being much less than in vegetative tissue. Technetium-99 was also shown to be toxic to plants at low concentrations and evidence suggests that this is a chemically rather than a radiologically induced toxicity. However, this remains to be completely resolved, as well as whether there is a threshold level of ^{99}Tc required before toxicity occurs.

25306 (COO—3011-6) **Radioactive foodchains in the subarctic environment. Progress report, August 15, 1975—August 14, 1976.** Miettinen, J.K. (Helsinki Univ. (Finland). Dept. of Radiochemistry). May 1976. Contract E(11-1)-3011. 20p. Dep. NTIS $3.50.

Cesium-137 is accumulated in the foodchain lichen-reindeer-man causing high body burdens in Lapps who have reindeer meat as staple food. A group of Finnish Lapps has been whole body counted for ^{137}Cs annually since 1961. Results of the measurements made in April 1976 show 18 percent decrease in ^{137}Cs body burdens from the previous year. A dietary study confirmed that there was no mentionable change in the total amount of reindeer meat consumed although winter consumption has slightly decreased and summer consumption increased in recent years. Plutonium analyses of stockpiled lichen and reindeer samples from 1960 to 1973 were begun in 1973; since then the sampling has continued. Lichen had 200 pCi per kg dry weight in 1963 to 1964, 100 pCi/kg in 1966 to 1970, 20 pCi/kg in 1973 to 1975. Biological half-time of plutonium in lichen is 2 years. Reindeer liver contained about 20 pCi per kg fresh weight in 1963, 2 pCi in 1973. The ratio of plutonium in liver to its lifelong total intake gave a lower limit to absorption in reindeer. Of bones, plutonium concentration is highest in teeth, medium high in sternum, vertebra

and humerus, and lowest in solid long bones. Human autopsy samples gave for lungs 0.19 liver 0.02 and bone 0.09 pCi ^{239,240}Pu per kg of wet weight.

25307 Availability of environmental radioactivity to honey bee colonies at Los Alamos. Hakonson, T.E.; Bostick, K.V. (Los Alamos Scientific Lab., NM). *J. Environ. Qual.;* **5**: No. 3, 307-310(1976).

Data are presented on the availability of tritium, cesium 137, and plutonium to honey bee colonies foraging in the environment surrounding the Los Alamos Scientific Laboratory. Sources of these radionuclides in the laboratory environs include liquid and atmospheric effluents and buried solid waste. Honey bee colonies were placed in three canyon liquid waste disposal areas and were sampled frequently, along with honey, surface water, and surrounding vegetation, to qualitatively determine the availability of these radionuclides to bees (Apis mellifera) and to identify potential food chain sources of the elements. Tritium concentrations in bee and honey samples from the canyons increased rapidly from initial values of <1 pCi/ml moisture to as much as 9.2 nCi/ml in 75 days after placement of the hives in the canyons. Seasonal patterns in foraging activities as influenced by weather and food availability were apparent in the data. It appears that several sources of tritium were utilized by the colonies, including surface water in the canyons and vegetation receiving tritium from atmospheric effluents and buried solid waste. Concentrations of cesium 137 and plutonium were generally low or undetectable in bees throughout the study. However, levels of both nuclides increased by factors of 10 to 20 in bees from two of the canyon study areas during a 3-month period in 1973. It was speculated that the liquid effluents in the two canyons were the source of the increased concentrations in bee samples, since this water was the only significant source of ^{137}Cs in the environs. The existence of at least three radionuclide sources in the Los Alamos Scientific Laboratory (LASL) environs complicates the interpretation of the data. However, it is apparent that honey bees can acquire ^{3}H, ^{137}Cs, and Pu from multiple sources in the environs.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 23974, 24151, 24866, 24873, 24879, 24880, 24881, 24882, 24883, 24887, 24889, 24892, 24914, 24915, 24920, 24921, 24922, 24928, 25299

25308 (ANL—76-XX-14) **Air pollution and the siting of fossil fuel power plants.** Fishelson, G.; Rausser, G.C.; Cohen, A.S. (Argonne National Lab., Ill. (USA); Chicago Univ., Ill. (USA). Center for Urban Studies). Jul 1976. Contract W-31-109-ENG-38;NSF-AG-352;NSF-GI-32989A2. 12p. Dep. NTIS $3.50.

The decision to locate a fossil-fueled electrical power plant on a particular site involves trade-offs among the costs of: (1) land acquisition, (2) plant construction, operation, and maintenance, (3) power transmission, and (4) air pollution damage to humans, animals, plants and materials. The fourth of these, pollution costs, has been of great concern in recent years. But seldom, if ever, are the specific dollar trade-offs between the environmental and the other costs associated with site selection taken into account. The sum of the costs of power generation (land, construction, operation, maintenance), power transmission, and air pollution damages (from sulfur dioxide, nitrogen oxides, and particulates) is the total social cost of a fossil-fuel plant; this total cost will generally vary by site. This paper presents an analysis of the total social cost, and the trade-offs between generation/transmission and air pollution costs, for various types of fossil plants at different sites in northern Illinois. The analysis identifies the combinations of site, fossil fuel, and sulfur dioxide (SO_2) control technology that minimize total social costs.

25309 (UCRL—78371) **Soil-structure interaction in nuclear power plants: a comparison of methods.** Wight, L.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1976. Contract W-7405-ENG-48. 9p. (CONF-770103—4). Dep. NTIS $3.50.

From 6. world earthquake conference; New Delhi, India (10 Jan 1977).

We performed an extensive parametric survey to analyze the differences between two methods of calculating soil-structure interaction. One method involves discretizing the soil-structure system and solving for the complete response with the LUSH computer code. The other method solves for the lumped mass structural response with Whitman soil springs. Twelve soil-structure interaction problems are solved by each of these methods. Representative results are presented and discussed. The debate within the nuclear industry in the United States over the relative merits of various methods of calculating soil-structure interaction has intensified over the last three years. The debate is largely the result of the U.S. Nuclear Regulatory Commission's position generally favoring the finite element approach. Certain sectors of the industry claim that this ruling is without technical basis, that it requires unnecessary expense, and that it inhibits the judgment of the analyst. We have addressed each of these points through lumped mass and finite element calculations on a set of twelve soil-structure interaction problems. The results of these calculations indicate some of the consequences of the choice of method.

REGULATIONS

REFER ALSO TO CITATION(S) 24877

ENVIRONMENTAL SCIENCES, AQUATIC

REFER ALSO TO CITATION(S) 24876, 24878

BASIC STUDIES

REFER ALSO TO CITATION(S) 24103, 25122, 25272, 25300

25310 (BNL—21899) **Regeneration of nitrogen by zooplankton and fish in the Northwest Africa and Peru upwelling ecosystems.** Whitledge, T.E. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract E(30-1)-16;NSF-G-GX-33502. 27p. Dep. NTIS $4.00.

The availability of nutrients and light are the dominant controlling factors of the levels of primary production in the ocean. In the lower latitudes where most coastal upwelling areas are located, the amount of light is seldom below the critical level to inhibit productivity so nutrients are often the limiting factor in phytoplankton growth. Nutrients utilized in primary productivity are derived from two sources in upwelling areas. Nutrients are introduced to the euphotic zone from depth by the physical processes that create upwelling and nutrients are recycled by biological organisms that inhabit the area. Nitrate introduced into the euphotic zone by upwelling supports new productivity while ammonium and other excretory products regenerated by zooplankton and nekton supports regenerated productivity. Results are reported from studies off the coast of Northwest Africa and Peru using ^{15}N as a tracer that showed that recycled ammonium may fulfill nearly half of the daily nitrogen requirement of phytoplankton and upwelled nitrate may provide the other half.

25311 (CONF-751096—, pp 177-193) **Chemistry of halogens in seawater.** Carpenter, J.H.; Macalady, D.L. (Univ. of Miami, FL). Jul 1976.

From Conference on the environmental impact of water chlorination; Oak Ridge, Tennessee, United States of America (USA) (22 Oct 1975).

In Environmental impact of water chlorination.

There has not been sufficient research to provide a satisfactory understanding of the reactions that occur when $+1$ oxidation state chlorine is added to seawater. However, present information suggests that the bromide ion is oxidized and, perhaps, disproportionates to several oxidation states. Formation of brominated or mixed brominated-chlorinated organic compounds can be expected but the extent and speciation of such reactions remain to be determined. Our experiments show that present analytical procedures do not measure all of the inorganic "residuals" present in chlorinated seawater.

25312 Herbivory as a factor in patterns of nutrient utilization in the sea. Walsh, J.J. (Univ. of Washington, Seattle). *Limnol. Oceanogr.;* **21**: No. 1, 1-13(Jan 1976).

A comparison of the horizontal nutrient gradients in coastal upwelling systems of the eastern boundary currents, in offshore divergences of high and low latitudes, and in the central gyres of the oceans suggests that changes in the dominant frequencies of variability of the physical habitat may define the importance of grazing stress as a constraint to nutrient utilization in the sea.

25313 Difficulties with ATP measurements in inshore waters. Sutcliffe, W.H. Jr. (Marine Ecology Lab., Dartmouth, Nova Scotia); Orr, E.A.; Holm-Hansen, O. *Limnol. Oceanogr.;* **21**: No. 1, 145-149(Jan 1976).

When inshore waters are filtered for microbial biomass determinations, the amount of ATP recovered in the extracts is directly proportional to the volume filtered up to about 0.5 liter. With sample volumes of 1 to 3 liters, there is an apparent loss of ATP which can amount to 10 to 50% of that originally present. This loss is not due to cell lysis during filtration, but rather seems related to adsorption phenomena associated with the load of detrital or sedimentary material in suspension. When working in inshore waters it is there-

fore advisable to determine if such an inflection point occurs for ATP loss and to use smaller sample volumes if necessary to ensure against any loss of ATP. There is no such loss of ATP from open ocean samples.

25314 (RLO—2225-T26-42(Vol.2)) **Biological oceanography of the northwest coastal zone. Progress report, June 1975—15 June 1976.** Perry, M.J.; Henry, D.P. (comps.). (Washington Univ., Seattle (USA). Dept. of Oceanography). Jun 1976. Contract E(45-1)-2225-TAS-26. 574p. Dep. NTIS $13.50.

Results are reported from investigations of the waters over the continental shelf off Washington. A series of cruises was designed, therefore, to provide seasonal information on the physical, chemical, and biological properties of this zone. Stations at closely spaced intervals were designated along latitude 47°07'N; the section extends from within two kilometers off Copalis Head to longitude 126°30'W, approximately 185 kilometers offshore. In addition, two 24-hour drift stations, one midway and the other at the western end of the sampling section, were established to provide measurements of in situ productivity and diel variations of hydrography, nutrient concentration, and phytoplankton standing stock. A compilation of the data collected in 1974 and 1975 on five cruises is presented. Part I deals with the methods of sampling and treatment of the data; the preliminary cruise reports are in Part II, and Parts III and IV present the data from the five cruises in tables and graphs, respectively.

RADIOMETRIC TECHNIQUES

25315 **Recovery of ^{14}C—CO_2 at high flow rates from a CHN analyzer.** Taft, J.L. (Johns Hopkins Univ., Baltimore). *Limnol. Oceanogr.*; 21: No. 1, 161-164(Jan 1976).

A simple method is described for efficiently absorbing ^{14}C-CO_2 from helium carrier gas flowing at rates up to 1 liter min^{-1}. The CO_2 trap can be coupled to a CHN analyzer to recover organic ^{14}C from freeze-dried seawater. The method is used to assess the significance of organic carbon release by natural populations of phytoplankton.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 23950, 24875, 25111, 25287, 25302, 25402, 25474

25316 (CONF-751096—) **Environmental impact of water chlorination.** Jolley, R.L. (ed.). (Oak Ridge National Lab., Tenn. (USA)). Jul 1976. 452p. Dep. NTIS $12.00.

From Conference on the environmental impact of water chlorination; Oak Ridge, Tennessee, United States of America (USA) (22 Oct 1975).

The formation of chlorine-containing organics during the chlorination of waters for drinking water sterilization, cooling water treatment, and sewage processing and disinfection is receiving much national attention. There exists a need for a thorough examination of the environmental effects of water chlorination. To meet this need the Conference on the Environmental Impact of Water Chlorination was held. Major objectives of the conference were to set down in the form of proceedings the present state of knowledge concerning aqueous chlorination with particular emphasis on chlorinated organic compounds and associated biomedical and environmental effects. The conference results and proceedings should establish a better understanding of both practical and theoretical aspects of water chlorination and perhaps set the stage for solving some of the concomitant problems. Separate entries were made for individual papers.

25317 (CONF-751096—, pp 7-24) **Current chlorination and dechlorination practices in the treatment of potable water, wastewater, and cooling water.** White, G.C. Jul 1976.

From Conference on the environmental impact of water chlorination; Oak Ridge, Tennessee, United States of America (USA) (22 Oct 1975).

In Environmental impact of water chlorination.

The present annual production of chlorine in North America is estimated at 10.5 million tons. Only 3 to 4 percent of this is used for sanitary purposes such as potable water and wastewater treatment, swimming pools, household use, cooling water circuits, and food packaging process water. The chemical industry accounts for at least 80 percent and the pulp and paper industry accounts for the rest, that is, about 15 to 16 percent. This is the perspective of chlorine in the environment.

25318 (CONF-751096—, pp 27-41) **Chemistry of aqueous chlorine in relation to water chlorination.** Morris, J.C. (Harvard Univ., Cambridge, MA). Jul 1976.

From Conference on the environmental impact of water chlorination; Oak Ridge, Tennessee, United States of America (USA) (22 Oct 1975).

In Environmental impact of water chlorination.

When chlorine is dispersed in water, a variety of molecular and ionic species is produced, including H_2OCl^+, HOCl and OCl^- as well as Cl_2. Of these the reactively dominant species for most aqueous chlorination reactions is HOCl. Other species generally are present in too small a concentration or have specific reactivities too low to be significant. The HOCl may act as an electrophilic reagent at either the oxygen or the chlorine atom. When reaction is at oxygen, chloride ion is formed by displacement, as has been shown for certain inorganic oxidations. For reactions at amine-N or at carbon the electrophilic attack is by the chlorine atom which acts as Cl^+. Reactions of chloramination, of chlorophenol formation or other aromatic substitution, of addition to double bonds, and of haloform formation are all examples of this form of electrophilic attack.

25319 (CONF-751096—, pp 43-71) **Measurement and persistence of chlorine residuals in natural waters.** Johnson, J.D. (Univ. of North Carolina, Chapel Hill). Jul 1976.

From Conference on the environmental impact of water chlorination; Oak Ridge, Tennessee, United States of America (USA) (22 Oct 1975).

In Environmental impact of water chlorination.

The nature and persistence of chlorination products classed as chlorine residuals are discussed by type of compound. Actual measurements of chlorine residual decay for free and combined chlorine in water, wastewater, and estuarine water are discussed. The decay of chlorine residuals by apparent first order specific rate constants of 0.03 hr^{-1} to 7.5 hr^{-1} are related to residual type, demand, volatility and photochemical effects. Present field, laboratory and continous methods for free and combined chlorine residual are compared for specificity, reagent stability, accuracy and simplicity. Included in this discussion are the acid orthotolidine methods, DPD, SNORT, LCV, FACTS, amperometric titration, copper-gold amperometric cells and the NBS flux monitor. A new analytical method specific for HOCl or NH_2Cl in the presence of the poor disinfectants OCl^-, organic chloramines and other interferences will be presented. The advantages and disadvantages of this method will be discussed in terms of selectivity, sensitivity, and other effects in disinfection efficiency measurements.

25320 (CONF-751096—, pp 73-83) **Organo-chemical implications of water chlorination.** Carlson, R.M.; Caple, R. (Univ. of Minnesota, Duluth). Jul 1976.

From Conference on the environmental impact of water chlorination; Oak Ridge, Tennessee, United States of America (USA) (22 Oct 1975).

In Environmental impact of water chlorination.

The desire for structural information on the specific organic compounds present in a given sample of renovated water makes it imperative that there be a basic understanding of those principles of mechanistic organic chemistry that apply to the situation in question. The process will be illustrated for aqueous chlorination, where the observed chlororganics can be readily explained on the basis of commonly recognized reactive intermediates and those stereochemical and electronic features associated with the organic moiety. The relationship of these mechanistic processes to pH, product distribution, BOD, oxidative capacity, and chloramine formation are considered.

25321 (CONF-751096—, pp 85-114) **Chlorination of organics in drinking water.** Stevens, A.A.; Slocum, C.J.; Seeger, D.R.; Robeck, G.G. (Environmental Protection Agency, Cincinnati). Jul 1976.

From Conference on the environmental impact of water chlorination; Oak Ridge, Tennessee, United States of America (USA) (22 Oct 1975).

In Environmental impact of water chlorination.

Halogenation of organic compounds occurs during chlorination of drinking water. The major known products of these reactions are trihalomethanes. Recognition of the potential health significance of these compounds has led to a search for alternatives to present treatment practice for potable water supplies. Some factors influencing trihalomethane production are precursor compound concentration, pH, type of disinfectant used (e.g., free vs. combined chlorine), and temperature. Appropriate control of these factors reduces concentrations of trihalomethanes in the finished water. The influence of these factors as determined by bench- and pilot-scale experiments is demonstrated and application of some appropriate control measures at a full-scale treatment plant is discussed.

25322 (CONF-751096—, pp 115-152) **Chlorination of organics in cooling waters and process effluents.** Jolley, R.L.; Jones, G.; Pitt, W.W.; Thompson, J.E. (Oak Ridge National Lab., TN). Jul 1976.

From Conference on the environmental impact of water chlorination; Oak Ridge, Tennessee, United States of America (USA) (22 Oct 1975).

In Environmental impact of water chlorination.

Many water-soluble chlorine-containing organic compounds of low volatility were found to be present in samples of chlorinated

cooling waters from electric power-generating plants and chlorinated effluents from domestic sanitary sewage treatment plants. Both types of samples had been chlorinated to mg/L chlorine concentrations in the laboratory under conditions similar to those used for treatment of cooling waters and disinfection of sewage effluents. The chlorinated constituents were separated from concentrates of the water samples by high-pressure liquid chromatography. Chlorination yields (as Cl) of the chloro-organic compounds, determined by using the radioactive tracer ^{36}Cl, ranged from 0.5 to 3.1% of the chlorine dosage. The formation of chloro-organics and the reaction yields correlated with the chemical compositions of the water samples. Several chloro-organics were identified in the typical domestic sewage effluents and were quantified at the μg/L level. Comparison of the chromatograms of the chlorinated constituents in the cooling water samples with those of the sewage process effluent samples revealed a high degree of correspondence with respect to the elution positions of the separated constituents. A compilation of relevant data concerning organic constituents in natural waters and sewage process effluent is presented. The chemical species subject to chlorination during the cooling water and sewage treatment are discussed.

25323 (CONF-751096—, pp 153-175) **Analysis of new chlorinated organic compounds formed by chlorination of municipal wastewater.** Glaze, W.H.; Henderson, J.E. IV; Smith, G. (North Texas State Univ., Denton). Jul 1976.

From Conference on the environmental impact of water chlorination; Oak Ridge, Tennessee, United States of America (USA) (22 Oct 1975).

In Environmental impact of water chlorination.

The effect of chlorination on secondary municipal wastewater effluents has been investigated using two analytical techniques. Total organic-bound chlorine (TOCl) is measured before and after chlorination by a microcoulometric procedure. Concentrated extracts of the effluent before and after chlorination at various chlorine dose levels are pyrolyzed and titrated in the Dohrmann halide analyzer. The TOCl results show a significant increase in the level of organic-bound chlorine after chlorination, particularly using large doses of chlorine (2000 to 4000 ppM). More explicit information regarding the nature of the new organic chlorine-containing compounds is obtained by gas chromatography/mass spectrometry studies of the concentrates obtained by XAD-2 resin extractions of the effluents. The GC/MS results confirm that chlorination causes the formation of many new chlorinated organics, the structures of over 50 of which have been identified. Whereas the majority of the compounds are aromatic halides, many are not derivatives of "activated" aromatics such as phenol but are simple derivatives such as chlorobenzenes, -toluenes, and -alkylbenzenes. Nonaromatic chlorides have also been identified. Particular attention has been focused in this work on the effect of heavy doses of chlorine in the range of 2000 to 4000 ppM. The TOCl and GC/MS results indicate that treatment of this type causes a very large increase in organic-chlorine content. Also reported are GC/MS data on XAD extracts of Denton, Texas, drinking water. Of particular interest are the occurrence of three iodine containing compounds, viz. dichloroiodomethane, dibromoiodomethane, and bromochloriodomethane in the finished water.

25324 (CONF-751096—, pp 213-227) **Halogenated organics in tap water: a toxicological evaluation.** Tardiff, R.G. (Environmental Protection Agency, Cincinnati); Carlson, G.P.; Simmon, V. Jul 1976.

From Conference on the environmental impact of water chlorination; Oak Ridge, Tennessee, United States of America (USA) (22 Oct 1975).

In Environmental impact of water chlorination.

Halogenated hydrocarbons are ubiquitous in the public water supplies of the United States. Of the compounds that have been identified in the nation's drinking water, approximately 34 percent are halogenated. A recent survey of five U. S. cities revealed that approximately 50 percent of the volatiles in tap water are halogenated. Although the number of volatile halogenated organics is relatively large, they constitute only a small percent of the total organic concentration in drinking water. Generally, chloroform is present in the highest concentration (approximately 100 ppB), and the majority of the other compounds are present in 1 ppB or less. Assessment of the toxicity of the organics in tap water is following two lines of investigation. Mixtures of organics from tap water are being bioassayed for mutagenic, carcinogenic, and teratologic activity. Specific compounds present in tap water are being subjected to in-depth toxicity evaluations. Among the compounds being investigated are the chloro-ethers, the chlorobenzenes, and the bromobenzenes. Compounds of interest for future research include the halomethanes and the chloroethanes. Toxicologic questions being addressed using these compounds include questions of extrapolation from experimental animals to man through investigations of comparative metabolism and predictability of synergistic interactions through studies of alterations of basic metabolic pathways.

25325 (CONF-751096—, pp 229-246) **Origin, classification, and distribution of chemicals in drinking water with an assessment of their carcinogenic potential.** Kraybill, H.F. (National Cancer Inst., Bethesda, MD). Jul 1976.

From Conference on the environmental impact of water chlorination; Oak Ridge, Tennessee, United States of America (USA) (22 Oct 1975).

In Environmental impact of water chlorination.

Of the wide array of chemical contaminants identified in potable waters some have carcinogenic activity referenced to studies with experimental animals. Some appear to be universally distributed both nationally and internationally. Some carcinogenic chemicals may be traced back to point source contamination while others may be formed or magnified to levels above those in raw water supplies during the chlorination process. Some carcinogenic chemicals fall into use classes such as pesticides, industrial chemicals, drugs, and other categories. Not all these chemicals classified as having carcinogenic potential or activity can be assessed as to their equivalent hazard. Differentiation is necessary to identify those that are well recognized as classical carcinogens and those that are of equivocal nature when referenced to experimental animal studies and may thus be termed suspect carcinogens. Some chemicals may be characterized as potential carcinogens on the basis of structural relationships or ancillary studies on mutagenicity. Many chemicals remain to be characterized for their carcinogenic activity. The integrated insult from multiple carcinogens in the water supply may have additive or inhibitory properties. This aspect of the problem remains to be qualified or quantified in terms of human risk assessment.

25326 (CONF-751096—, pp 247-258) **Potential for increased mutagenic risk to the human population due to the products of water chlorination.** Cumming, R.B. (Oak Ridge National Lab., TN). Jul 1976.

From Conference on the environmental impact of water chlorination; Oak Ridge, Tennessee, United States of America (USA) (22 Oct 1975).

In Environmental impact of water chlorination.

In the model studies described in this paper, 5-chlorouracil (5-ClU) has been tested in several mammalian and submammalian genetic test systems. The incorporation of 5-ClU into the DNA of mice which had been exposed to this compound in their drinking water has been measured. Both a specific-locus mutation test and a dominant-lethal mutation test have been performed on mice which have been similarly exposed. The compound has been tested for mutagenicity in several types of bacteria and has been found to be highly mutagenic in E. coli. The data from 5-ClU incorporation studies into the DNA of mice together with the specific-locus mutation data allow the calculation of the upper 95 percent confidence limit for mutations induced in the human population at environmental exposure levels. This calculation demonstrates that 5-ClU, by itself, does not pose a significant genetic hazard to humans at current release levels. The more significant question of whether, in sum, all of the chlorine-containing organic compounds produced by water chlorination pose a significant hazard is yet to be determined.

25327 (CONF-751096—, pp 259-274) **Epidemiologic approach to the evaluation of water-borne carcinogens.** Cantor, K.P. (Environmental Protection Agency, Washington, DC). Jul 1976.

From Conference on the environmental impact of water chlorination; Oak Ridge, Tennessee, United States of America (USA) (22 Oct 1975).

In Environmental impact of water chlorination.

The classic mid-19th Century London study of John Snow, in which cholera was linked to water-borne contamination, is reviewed to provide a context for discussing the epidemiologic approach to evaluation of carcinogens in drinking water. The value of epidemiologic studies arises from the fact that observations are made directly on human populations so that extrapolation from animal models and/or unrealistically high doses is not necessary to predict effects in humans. Limitations of the approach include the long latent period for most cancers, difficulties in estimating dose, the definition of at-risk populations, and the relatively low exposure levels to carcinogenic agents. Recent studies of a preliminary nature are reviewed.

25328 (CONF-751096—, pp 277-298) **Toxicity of chlorine to freshwater organisms under varying environmental conditions.** Brooks, A.S.; Seegert, G.L. (Univ. of Wisconsin, Milwaukee). Jul 1976.

From Conference on the environmental impact of water chlorination; Oak Ridge, Tennessee, United States of America (USA) (22 Oct 1975).

In Environmental impact of water chlorination.

Chlorine enters freshwater systems from many sources. It enters waters of variable chemical quality in a variety of chemical forms over wide ranges of temperature and for varying periods of time. Each of these factors is important in determining the toxicity of chlorine to aquatic life. This paper reviews studies which have been conducted under a myriad of environmental conditions in attempts to quantify the toxicity of chlorine to freshwater organisms. Included in the review are experiments run in relatively clean waters and sewage effluents. Studies are also included which involved continuous and intermittent chlorine applications and tests conducted under a wide range of temperatures. Data from these studies are reviewed in light of the conditions under which the tests were conducted. A

synthesized view is presented of the toxicity of chlorine to freshwater biota in terms of the level and duration of exposure, temperature, and the chemical nature of the water in which the experiments were conducted.

25329 (CONF-751096—, pp 299-325) **Review of the impact of chlorination processes upon marine ecosystems.** Davis, W.P.; Middaugh, D.P. (Gulf Breeze Environmental Research Lab., Wadmalaw Island, SC). Jul 1976.

From Conference on the environmental impact of water chlorination; Oak Ridge, Tennessee, United States of America (USA) (22 Oct 1975).

In Environmental impact of water chlorination.

For over 175 years chlorine gas has been used in industrial, biocidal, and disinfection applications. The chemistry of chlorine in freshwater is relatively well known, but long-range effects on the organisms and the ecological communities of marine waters have barely been studied. Until recently, the so-called chlorine demand of treated or receiving waters has been considered a desirable feature which assured degradation of actively oxidizing states of chlorine to a nontoxic state. With continuing and increased use of chlorine as an antifouling biocide in powerplants, and as a disinfectant of municipal wastes, concern has arisen that resulting byproducts, such as induced halogenated hydrocarbons, could potentially reach environmentally harmful levels. For example, in the State of Maryland the quantity of chlorine used, which subsequently reaches the Chesapeake Bay, would have sterilized that body of water were not chemical/biological degradation processes in effect. But, what are the limits of natural degradation processes in effect. But, what are the limits of natural degradation systems. What, for one example, are the known environmental costs of our present rates of chlorine applications on renewable fishery resources. What kind and at what rate are persistent halogenated compounds being produced. Where do these go in natural systems. From partial or complete answers to these questions will come meaningful environmental management criteria. This paper presents a theoretical degradation model of chlorine added to marine waters. Additionally it summarizes literature reporting laboratory or ecological effects of chlorine.

25330 (CONF-751096—, pp 327-345) **Chlorinated compounds found in waste-treatment effluents and their capacity to bioaccumulate.** Kopperman, H.L. (Univ. of Minnesota, Duluth); Kuehl, D.W.; Glass, G.E. Jul 1976.

From Conference on the environmental impact of water chlorination; Oak Ridge, Tennessee, United States of America (USA) (22 Oct 1975).

In Environmental impact of water chlorination.

As part of an ongoing research program to assess possible long-term environmental effects due to the formation of stable reaction products during disinfection processes, fish (fathead minnows, Pimephales promelas) and water from the 9-month chronic toxicity tests at two wastewater treatment plants in Michigan are being analyzed for chemical residues at this laboratory (formerly named the National Water Quality Laboratory). Gel permeation chromatography was used for sample clean-up and gas chromatography/mass spectrometry was used for sample analysis. Di- and trichlorophenols, di- and trichlorobenzenes, and trichloroanisoles were either not detected or detected at lower levels in the fish from nondisinfected effluent exposures compared to fish exposed to chlorinated effluent. Tetra- and pentachlorophenols, PCB's, DDT's, toxaphene components, chlordane, and nonachlor were found in all fish raised in the sewage effluent. Tribromoanisole was tentatively identified in fish that lived in BrCl-treated wastewater. Reports appear to be conclusive in support of the argument that even the most gentle chlorination conditions will cause chlorine to be incorporated into organic molecules. The incorporation of chlorine into an organic molecule increases its lipophilic character and at the same time normally causes an increase in the observed toxicity or bioaccumulation, or both. The persistence of these compounds is now becoming a concern. Not all organochlorine compounds bioaccumulate to high levels. The data suggests that polar compounds are more easily biodegraded, and the nonpolar (highly lipophilic) compounds accumulate. Some investigators have been able to demonstrate positive correlation between the n-octanol/water partition coefficients for given compounds and their ability to bioaccumulate in various species of fish.

25331 (CONF-751096—, pp 347-362) **Investigating the effects of chlorinated organics.** Gehrs, C.W.; Southworth, G.R. (Oak Ridge National Lab., TN). Jul 1976.

From Conference on the environmental impact of water chlorination; Oak Ridge, Tennessee, United States of America (USA) (22 Oct 1975).

In Environmental impact of water chlorination.

The recent identification of stable chlorine-containing organics arising from the chlorination of natural waters has revealed a group of reaction products whose toxicities to aquatic organisms are unknown. In this paper we present information on the toxicity of two chlorinated compounds (5-chlorouracil and 4-chlororesorcinol) and a mixture of identified chlorinated organics or zooplankton and fish. We compare data emphasizing differences in relative toxicity depending on the response parameter used. Problems associated with studying individual compounds and complex mixtures are discussed and a systematic approach for overcoming the identified shortcomings presented.

25332 (CONF-751096—, pp 365-385) **Modeling residual chlorine levels: closed-cycle cooling systems.** Nelson, G.R. (Environmental Protection Agency, Cincinnati). Jul 1976.

From Conference on the environmental impact of water chlorination; Oak Ridge, Tennessee, United States of America (USA) (22 Oct 1975).

In Environmental impact of water chlorination.

A mathematical model which predicts residual chlorine levels in cooling tower blowdown streams at any time during the chlorination cycle is discussed in this paper. To quantify the absence or presence of residual chlorine in the blowdown, the model interprets residual chlorine as negative chlorine demand. The general model has eight variations applying to specific chlorination program characteristics. The program characteristics affecting the general model are: split stream vs. no split stream chlorination (the fraction of the recirculating water chlorinated); residual data feedback vs. no residual data feedback (the type of chlorine feed equipment used); and positive vs. negative demand at the end of the chlorine feed period (the time length of the chlorine feed period). The variations to the model are useful not only in predicting residual chlorine levels in the blowdown, but also in making alterations in existing chlorination programs which minimize chlorine waste, provide more disinfecting efficiency, and reduce chlorine levels in the blowdown.

25333 (CONF-751096—, pp 403-422) **Assessing toxic effects of chlorinated effluents on aquatic organisms: a predictive tool.** Mattice, J.S. Jul 1976.

From Conference on the environmental impact of water chlorination; Oak Ridge, Tennessee, United States of America (USA) (22 Oct 1975).

In Environmental impact of water chlorination.

Increased chlorination of surface waters has necessitated development of an analytical tool for assessing the toxicity of a chlorinated effluent so that environmental damage may be minimized. The tool proposed includes length of exposure as well as concentration as factors of importance and allows for protective limitations to be applied to releases on a site specific basis. Cornerstones of the assessment tool are acute and chronic mortality thresholds. The thresholds are derived by summarizing extant chlorine toxicity data (mostly as median tolerance limits) in log concentration-log duration plots, bounding these data points from below with straight lines to estimated acute and chronic median lethal thresholds, and shifting the acute median lethal threshold to estimate a true mortality threshold (zero mortality) using an empirically derived relationship between exposure time necessary to yield fifty and zero percent mortality. Dose-time exposures for organisms entrained through the plant and into the discharge plume are compared with these thresholds to derive yes or no decisions regarding mortality. Limits may then be set to minimize environmental harm. Accurate plume dilution data are necessary for optimal application of this procedure, but parameters which increase discharge dilution rate are taken into consideration.

25334 **Contribution of gut contents to the concentration and body burden of elements in Tipula spp. from a spring-fed stream.** Elwood, J.W.; Hildebrand, S.G.; Beauchamp, J.J. (Oak Ridge National Lab., TN). *J. Fish. Res. Board Can.*; 33: No. 9, 1930-1938(1976).

Larvae of Tipula spp., a detritus-feeding aquatic insect collected from an unpolluted springfed stream, were analyzed for 30 elements before and after gut evacuation to determine the contribution of gut contents to whole-body concentrations. Chromium and Al concentrations were inversely related to body size, suggesting surface contamination. All elements analyzed except Na, Cr, Hg, Zn, and Se were significantly lower ($P < 0.01$) in concentration after gut evacuation (18% decrease for K to approximately 70% for V, Mn, Hf, and some of the rare earths). Ratios of variances of mean concentrations in organisms with guts filled to those with guts evacuated indicate that gut contamination is a major source of variation in measured whole-body concentrations of many elements. Calculated percentage of element body burden associated with gut contents ranged from <1% for Na to 89% for Zr, with a mean for all elements analyzed of 57 +- 8%(+- 2 SE). Calculated trophic transfer factors (TTF = element concentration in larvae with guts evacuated/concentration in leaf detritus) for elements which are obtained primarily through the food chain were significantly <1 only for Zn; TTFs for all other elements were less than or equal to 1.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 24119, 25117, 25293

25335 (HASL—315(App.), pp C.1-C.7) **Radiostrontium in milk and tap water.** 1 Jan 1977.

In Appendix to Health and Safety Laboratory environmental quarterly, September 1, 1976—December 1, 1976.

Data are presented on the content of ^{90}Sr in samples of milk and drinking water and ^{137}Cs in water collected in New York city during 1976.

25336 (UCRL—51974) **Interactions of radionuclides in water, particulates, and oysters in the discharge canal of a nuclear power plant.** Harrison, F.L.; Wong, K.M.; Heft, R.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Aug 1976. Contract W-7405-ENG-48. 46p. Dep. NTIS $4.00.

This study was designed to provide data for dynamic modeling of radioactive pollutants in marine ecosystems adjacent to nuclear power plants. The data are relevant to the dynamics of radionuclide transfer among seawater, suspended particulates, sediments, and biota. Gamma-emitting radionuclides (^{54}Mn, ^{60}Co, ^{65}Zn, and ^{137}Cs) were followed in the water and particulates, as well as in oysters introduced into the discharge canal of the boiling water reactor of the Humboldt Bay Power Plant near Eureka, California. The liquid waste was introduced into the canal at irregular intervals and contained radionuclides at extremely low but variable concentrations. Radionuclides were determined in the oysters, water, and particulates after single releases (over about 6 hr) and over a long series of releases (18 months).

WATER

REFER ALSO TO CITATION(S) 24122

AQUATIC ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 25336

THERMAL EFFLUENTS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 24884

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 24866, 24883, 24884, 24886, 24890, 24891, 25299

REGULATIONS

REFER ALSO TO CITATION(S) 24877, 24878

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 24737, 24866, 24868, 24872, 24873, 24874, 24929, 25274

ASSESSMENT OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 24156, 24701, 24868, 24880, 24882, 24884, 24885, 24886, 24887, 24888, 24889, 24890, 24891, 24894, 24935

25337 (ERDA-tr—240) **Is there a plutonium problem.** Stoll, W. Translated from *Atomwirtsch., Atomtech.;* **20**: 419-423(1975). 10p. Dep. NTIS $3.50.

Four contradictions are especially conspicuous when considering the Pu problem. These are: there is already too much of it today and yet, at this time, there is not enough available; it is one of the strongest of poisons and still it can hardly be demonstrated that anyone at all has ever been injured by it; it is not worthwhile to separate it from the fission products, and still it can become our most important energy carrier; among the nuclear catchwords, only the supermaximum credible accident of the reactor competes with it for first place in concern of the public, and still an entire coming fast breeder generation depends on its existence and purposeful increase for energy production.

ENVIRONMENTAL IMPACT STATEMENTS

REFER ALSO TO CITATION(S) 24920, 24921, 24922, 24923, 24924

BIOMEDICAL SCIENCES, BASIC STUDIES

BEHAVIORAL BIOLOGY

REFER ALSO TO CITATION(S) 25472

25338 (UR—3490-999) **Behavioral toxicology of organic solvents and volatile anesthetics.** Wood, R.W. (Rochester Univ., N.Y. (USA)). 6 Sep 1976. Contract E(11-1)-3490;NIDA-G-DA-00623. 28p. (CONF-760996—1). Dep. NTIS $4.00.

From Symposium on the neurobehavioral effects of environmental pollutants of the American Psychological Association; Washington, District of Columbia, United States of America (USA) (6 Sep 1976).

Some topics discussed are as follows: induction of liver cancer in personnel working with vinyl chloride; self-administration of volatile anesthetics and hydrocarbons by inhalation; effects of chloroform, lacquer thinner, and ether on behavior of macaques; effects of nitrous oxide on behavior of squirrel monkeys; toxic effects of industrial grades of toluene; extrapolation of data from primate self-administration models to man; and screening of chemicals for toxic effects by the proposed Toxic Substances Control Act. (HLW)

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 25357, 25385

25339 (COO—2964-1) **Chemical and biological studies on nucleic acids and derivatives. Progress report, May 1, 1975—July 31, 1976.** Brown, G.B.; Parham, J.C. (Sloan-Kettering Inst. for Cancer Research, New York (USA)). Oct 1976. Contract E(11-1)-2964. 25p. Dep. NTIS $3.50.

The photochemical products from N-oxidized purines in solution are strongly dependent on the tautomeric and ionic state of the compounds. Studies have been done on the effect of pH on the quantum efficiencies of photoreduction and photorearrangement of a 1-hydroxypurine, a purine 3-oxide and hypoxanthine 3-oxide, a compound that exists as a tautomeric N-oxide-N-hydroxyl equilibrium. The quantum yields for each photoreaction from each tautomer of the nonionized species and from the anions have been determined. In every case photoreduction is promoted in the presence of triplet sensitizers.

25340 **Methylenetetrahydrofolate reductase in the rat central nervous system: intracellular and regional distribution.** Burton, E.G.; Sallach, H.J. (Univ. of Wisconsin, Madison). *Arch. Biochem. Biophys.;* **166**: 483-494(1975).

Methylenetetrahydrofolate reductase and methyltetrahydrofolate-homocysteine methyltransferase were found to be localized in the soluble fraction of rat brain. They are clearly separated from serine hydroxymethyltransferase and the glycine cleavage complex which are localized in the mitochondria in this tissue. Hence, although the primary, if not the only, site of 5, 10-methylenetetrahydrofolate formation in brain appears to be the mitochondrion, the utilization of this compound for 5-methyltetrahydrofolate synthesis and utilization of the latter compound for methylation of homocysteine occurs in the cytosol. Parallel experiments with rat liver confirmed that the reductase and homocysteine methyltransferase of this tissue are also localized in the soluble fraction, while the hydroxymethyltransferase is about evenly divided between mitochondria and cytosol. However, in liver (but not in brain) the reductase activity of the supernatant fraction is only partially expressed unless the fraction is dialyzed. We have found that this phenomenon, which initially suggested the occurrence of an endogenous inhibitor in liver extracts is due to loss of the product (5, 10-methylenetetrahydrofolate) of the reductase assay via its oxidation by methylenetetrahydrofolate dehydrogenase, in combination with the NADP present in undialyzed extracts. All regions of the rat central nervous system tested contained methylenetetrahydrofolate reductase activity. Regional variations were observed however, with an almost threefold difference between the specific activities of the highest and lowest ranking regions. Comparison of the rank order of 12 regions tested with respect to reductase specific activity (this study) and methyltetrahydrofolate-tryptamine N-methyltransferase specific activity shows a high positive correlation ($r = 0.916$) between these activities in the selected regions.

25341 Mechanism of action of ruthenium red compounds on Ca^{2+} ionophore from sarcoplasmic reticulum (Ca^{2+} + Mg^{2+})-adenosine triphosphatase and lipid bilayer. Shamoo, A.E.; Thompson, T.R.; Campbell, K.P.; Scott, T.L.; Goldstein, D.A. (Univ. of Rochester, NY). *J. Biol. Chem.;* **250**: No. 20, 8289-8291(1975).

Sarcoplasmic reticulum (Ca^{2+} + Mg^{2+})-ATPase was previously shown to have Ca^{2+}-dependent and -selective ionophoric activity when tested in oxidized cholesterol lipid bilayer membranes (Shamoo, A. E., and MacLennan, D. H. (1974) Proc. Natl. Acad. Sci. U. S. A. 71, 3522). Ruthenium red, a known inhibitor of (Ca^{2+} + Mg^{2+})-ATPase, is found to inhibit the Ca^{2+}-ionophoric activity associated with (Ca^{2+} + Mg^{2+})-ATPase. Furthermore, ruthenium red alone acts as an anion-selective ionophore in lipid bilayers with the following selectivity sequence for anions: $I^- < Cl^-$, $Br^- < F^- <$ NO_3p. The P/sub Cl^-//P/sub Na^+/ ratio was ~4/1. The presence of ruthenium red in excess of Ca^{2+} ionophore in lipid bilayer experiments converts the cation selectivity of the bilayer due to Ca^{2+} ionophore into anion selectivity.

25342 Porphyrins and related compounds as photodynamic sensitizers. Spikes, J.D. (Univ. of Utah, Salt Lake City). *Ann. N.Y. Acad. Sci.;* **24**: 496-508(15 Apr 1975).

It was shown early in this century that certain porphyrins are photosensitizers of the photodynamic type, i.e., they sensitize the photooxidative damage of biological systems on illumination in the presence of molecular oxygen. An extensive literature has accumulated on porphyrin-sensitized photodynamic effects on multicellular organisms (including humans), cells, biomacromolecules, and small organic molecules of biological importance. The mechanism of the porphyrin-sensitized injury to multicellular organisms is poorly understood; effects at the cellular level appear to be mediated by photodynamic damage to plasma and lysosomal membranes. Damage to proteins involves the photooxidation of certain types of amino acid residues. Efficiencies of porphyrins as photodynamic sensitizers depend critically on the metal chelated by the molecule; porphyrins containing paramagnetic metal atoms are typically nonsensitizers. The sensitizing efficiencies and substrate specificities of metal-free and diamagnetic metalloporphyrins are determined to some extent by the side chains on the molecule. In water solution, photosensitizing porphyrins give a good yield of long-lived triplet states on illumination which are quenched by molecular oxygen with high efficiency. Kinetic and product-formation studies with amino acids and proteins suggest that porphyrin-sensitized photooxidations occur by a singlet oxygen mechanism. The purpose of this paper is to review briefly the various kinds of studies that have been made with porphyrins as photosensitizers; the coverage of the literature is extensive rather than intensive in order to illustrate the great range of systems studied.

25343 Porphyrin-sensitized photooxidation of horseradish apoperoxidase. Kang, Y.J.; Spikes, J.D. (Univ. of Utah, Salt Lake City). *Arch. Biochem. Biophys.;* **172**: 565-573(1976).

Horseradish apoperoxidase (apoHRP) was reconstituted with various porphyrin derivatives, e.g., ferric, cupric, manganese, and zinc protoporphyrin IX, metal-free protoporphyrin IX, hematoporphyrin IX and deuteroporphyrin IX. The visible absorption spectra of these porphyrin-apoHRP complexes were examined. The time required for maximum development of the new Soret peak after reconstitution was used to measure the rate of porphyrin-apoHRP reconstitution. All of the four metal-protoporphyrins reconstituted with apoHRP at the same rate as metal-free protoporphyrin IX, whereas, for the metal-free porphyrins, the rates of reconstitution were in the order of deuteroporphyrin IX < hematoporphyrin IX < protoporphyrin IX. The porphyrins on the reconstituted porphyrin-apoHRP complexes were used as localized photosensitizers for photodynamic studies. No amino acid residues were oxidized on illumination of the ferric, cupric and manganese protoporphyrin IX-apoHRP complexes due to the paramagnetic properties of these metal ions. With diamagnetic zinc ion, two histidine and one methionine residues were oxidized, which was the same as in the protoporphyrin IX- and hematoporphyrin IX-apoHRP complexes. However, only one histidine was destroyed on illumination of the deuteroporphyrin IX-apoHRP complex. The results confirmed the resistance of horseradish peroxidase to photodynamic action and suggested the involvement of at least one histidine residue in the heme environment of horseradish peroxidase.

25344 Detection of an essential sulfhydryl group in phosphoglycerate mutase with an affinity-labeling reagent. Hartman, F.C.; Norton, I.L. (Oak Ridge National Lab., TN). *J. Biol. Chem.;* **251**: No. 15, 4565-4569(1976).

N-Bromoacetylethanolamine phosphate rapidly and irreversibly inactivates rabbit muscle phosphoglycerate mutase. At high molar ratios of reagent to enzyme, loss of activity (both mutase and phosphatase) approximates pseudo-first order kinetics. A rate-saturation effect is observed with half-maximal rate of inactivation occurring at 0.32 mM reagent, a value close to the K/sub m/ for 3-phosphoglyceric acid. This datum and the dissociation constant of the 2,3-bisphosphoglycerate-enzyme complex, as determined from inactivation kinetics in the presence of the bisphosphate, suggest that the reagent reacts at the substrate binding site. Inactivation results from the covalent incorporation of about 0.8 mol of reagent/mol of catalytic subunit as determined with ^{14}C-labeled reagent. Incorporation is negligible in the presence of substrate and is reduced 8-fold in the presence of 6 M urea. From amino acid analyses on acid hydrolysates of the inactivated enzyme, we have identified a sulfhydryl group as the site of alkylation. A peptide containing the essential sulfhydryl group has been isolated from a tryptic digest of the enzyme inactivated with labeled reagent; its amino acid composition is Trp_1, Lys_1,$Cys(Cm)_1$,Asp_1,Ser_1,Glu_2,Gly_1,Ala_1,Leu_1,Phe_2.

25345 Structure of corylifuran: a clerodane-type diterpene from Croton corylifolius Lam. Burke, B.A. (Univ. of the West Indies, Kingston, Jamaica); Chan, W.R.; Prince, E.C.; Manchand, P.S.; Eickman, N.; Clardy, J. *Tetrahedron;* **32**: No. 15-C, 1881-1884(1976).

The structure and stereochemistry of corylifuran, a clerodane-type diterpene from Croton corylifolius Lam, have been determined as 2 by chemical and spectroscopic data and X-ray crystallographic analysis.

25346 Mechanisms of suppression in Drosophila. IV. Specificity and properties of tyrosyl-tRNA synthetase. Warner, C.K.; Jacobson, K.B. (Oak Ridge National Lab., TN). *Can. J. Biochem.;* **54**: 650-656(1976).

Tyrosyl-tRNA synthetase from wild type Drosophila can distinguish tRNA/sup Tyr/ of wild type from that of the suppressor mutant, $su(s)^2$. The method of fractionation of the enzyme on DEAE-cellulose can produce three different forms of the enzyme. One of these forms is characterized in this study. We describe the apparent k/sub m/ for K^+, Mg^{2+}, ATP, tyrosine and tRNA, as well as its heat stability and molecular weight. Spermine does not replace Mg^{2+} but is inhibitory; a K/sub i/ of 1 mM was obtained. Inhibition by p-chloromercuribenzoate results in a K/sub i/ of 1 μM. The properties of tyrosyl-tRNA synthetase of Drosophila are compared to the properties of this enzyme from E. coli, B. subtilis and yeast.

25347 Coordinate activation of a multienzyme complex by the first substrate. Evidence for a novel regulatory mechanism in the polyaromatic pathway of Neurospora crassa. Welch, G.R.; Gaertner, F.H. (Oak Ridge National Lab., TN). *Arch. Biochem. Biophys.;* **172**: 476-489(1976).

The catalytic efficiencies of four of the five enzymes of the aromatic complex of Neurospora crassa were significantly increased by incubation with the first substrate, 3-deoxy-D-arabino-heptulosonate 7-phosphate (DAHP). Activation with DAHP was accomplished independently of catalysis by incubating the purified enzyme system in a mixture devoid of requisite cofactors and intermediate substrates. The activity of each enzyme in the complex was subsequently assayed in appropriate complete reaction mixtures. Double-reciprocal plots of the kinetic data were used to determine the effect of DAHP on the catalytic constants of each enzyme. The results for five enzymes, dehydroquinate synthase, dehydroquinase, dehydroshikimate reductase, shikimate kinase, and enolpyruvylshikimate phosphate synthase, were as follows. Incubated in the absence of DAHP (i.e. unactivated) the maximal velocities (V) in relative units were 1, 20, 4, 2, and 5, respectively, and the K/sub m/ values were 0.06, 0.1, 0.04, 0.1, and 0.1 mM for the respective substrates. In direct comparison, when the complex was incubated with DAHP (i.e. activated), the V values were 2, 20, 4, 2, and 5 and the K/sub m/ values were ~0.01, 0.02, 0.02, 0.1, and 0.02 mM. The concentration of DAHP required for half-maximal activation in each case was approximately 1.0 mM. This suggests but does not prove that a single site, distinct from the catalytic site, is responsible for the coordinate activation. We propose that the physiological importance of the activation involves a novel regulatory device that provides a means for directing the flow of aromatic intermediates from the anabolicpolyaromatic route to a catabolic one in response to the energy charge of the cell. In support of this view are the facts that shikimate kinase was found to be inhibited by ADP and that, as a result of the activation of the other four enzymes in the complex, shikimate kinase becomes rate limiting and catalyzes a nonequilibrium reaction.

25348 Single-strand nuclease action on heat-denatured spermiogenic chromatin. Hunter, J.D.; Bodner, A.J.; Hatch, F.T.; Balhorn, R.L.; Mazrimas, J.A.; McQueen, A.P.; Gledhill, B.L. (Univ. of California, Livermore). *J. Histochem. Cytochem.;* **24**: No. 8, 901-907(1976).

The sensitivity of chromatin was compared from representative cellular stages of spermiogenesis to a single-stranded nuclease after heat denaturation. Thermal denaturation of chromatin was assayed in situ in fixed round, elongating and elongated spermatids and in testicular sperm from mice. Production of single-stranded deoxyribonucleic acid (DNA) at elevated temperatures was monitored by digesting chromatin with endonuclease specific for single-stranded DNA (S/sub 1/ nuclease), staining the residual DNA with gallocyanin-chrome alum (GAC) and measuring the stain content by absorption cytophotometry. Changes in GCA staining were minimal

over the temperature range of 22-90°C in each cell type not exposed to nuclease. Staining of undigested cells decreased progressively with advancing cell maturity. Nuclease had no effect on the GCA content of round spermatids below 60°C, but above this temperature there was a progressive decrease in GCA-stainable chromatin. Both round and elongating spermatid stages showed a significantly greater sensitivity to nuclease digestion than did more mature stages; sperm showed no effects of nuclease action below 80°C. Progressive chromatin condensation and a concomitant decrease in the number of available DNA phosphate groups during spermiogenic cell maturation may be responsible for the observed decline in sensitivity to nuclease and decreased GCA staining. Thermal denaturation of roundspermatids labeled with ^{3}H-thymidine produced no change in autoradiographic mean nuclear grain counts, indicating no loss of thymidine-labeled DNA from the slides during denaturation. When round spermatids and sperm were hydrolyzed with hot trichloracetic acid before staining, both nuclear GCA content and autoradiograph grain count were partially reduced, indicating incomplete DNA removal. Almost complete loss of Feulgenstainable material occurred in these cells and may be due to depurination and elimination of Fuelgren-reactant aldehyde groups.

25349 Studies on DNA repair in early spermatid stages of male mice after in vivo treatment with methyl-, ethyl-, propyl-, and isopropyl methanesulfonate. Sega, G.A.; Owens, J.G.; Cumming, R.B. (Oak Ridge National Lab., TN). *Mutat. Res.;* **36**: 193-212(1976).

In vivo DNA repair occurring in early spermatid stages of the mouse has been studied with four mutagens that are chemical homologs: MMS, EMS, PMS and IMS. Using the well-studied sequence of events that occurs during spermatogenesis and spermiogenesis in the mouse, and administering testicular injections of [^{3}H]dT, repair in early spermatids was measured by the unscheduled inc ɔrporation of [^{3}H]dT into these germ cells which were recovered from the caudal epididymides 16 days after chemical treatment. Purification of the caudal sperm DNA at this time verified that the [^{3}H]dT was incorporated into the DNA. For each chemical mutagen a study was made on the level of DNA repair occurring in early spermatids as a function of the administered, in vivo dose. Within experimental errors, all four chemicals produced a linear increase in DNA repair in early spermatids with increasing dose. Only the highest dose of MMS (100 mg/kg) produced a greater repair response than expected for a linear curve. At equimolar doses the most effective chemical in inducing DNA repair was MMS, followed by EMS, IMS and PMS. When testicular injections of [^{3}H]dT were given at the same time as the intraperitoneal injections of the mutagens, the amount of unscheduled incorporation of [^{3}H]dT into the DNA of early spermatids was maximized.

25350 Equilibrium dialysis and circular dichroic analysis of the novobiocin-bovine serum albumin complex. Brand, J.G.; Toribara, T.Y. (Univ. of Rochester, NY). *Arch. Biochem. Biophys.;* **174**: 541-545(1976).

The binding of the drug novobiocin by bovine serum albumin has been analyzed by Scatchard plots at two temperatures and three ionic strengths. In all cases the nonlinearity of the plots indicates heterogeneity of the combining sites on the protein, and an analysis of the changes observed in the circular dichroic spectra of the bound drug supports this observation. By use of a three-constant model the best fit for all of the parameters is achieved by assuming the initial site on the protein to be unique, the next five sites to be homogeneous, and subsequent binding to be described by a simple distribution between two phases. The temperature variation studies reveal that the first site derives its free energy of binding totally from a favorable change in entropy while the second class of five sites derives their free energy of binding from a favorable enthalpy change. Comparisons are made between the binding of novobiocin by bovine albumin and by human albumin.

25351 Map of the sites of bacteriophage PM2 DNA for the restriction endonucleases HindIII and HpaII. Brack, C.; Eberle, H.; Bickle, T.A.; Yuan, R. (Univ., Basel). *J. Mol. Biol.;* **104**: 305-309(1976).

The map of the seven sites for the restriction endonuclease HindIII double dagger and the single site for endo R.HpaII on PM2 DNA was determined. This map was oriented with respect to the denaturation map of this DNA (Brack et al., 1975) by partial denaturation mapping of the fragments. A new method for localizing restriction fragments by DNA-DNA hybridization and electron microscopy is described.

25352 (UCRL-Trans—11194) Occurrence of N/sup ϵ/-(β-aspartyl) lysin and N/sup ϵ/-(γ-glutamyl) lysin isopeptide bonds in bovine colostrum. Klostermeyer, H.; Rabbel, K.; Reimerdes, E.H. Translated from *Z. Physiol. Chem.;* **357**: 1197-1199(Aug 1976). 10p. Dep. NTIS $3.50.

In bovine colostrum which was defatted and totally hydrolyzed by protcolytic enzymes, isopeptides were identified by ionexchange chromatography and preparative separation. Isopeptides were identified in two of seven samples of colostrum. It is still to be clarified whether there is a correlation between the amount of γ-glutamyltransferase and the appearance of these crosslinkings.

25353 ^{13}C nuclear magnetic resonance spectroscopy of suspensions of Chinese hamster ovary cells specifically enriched with [methyl-^{13}C]choline. London, R.E.; Hildebrand, C.E.; Olson, E.S.; Matwiyoff, N.A. (Los Alamos Scientific Lab., NM). *Biochemistry;* **15**: No. 25, 5480-5486(14 Dec 1976).

The mammalian Chinese hamster ovary cell line (CHO) was labeled with [methyl-^{13}C]choline. Under the conditions used, approximately 42% of the cellular choline was found to be associated with cellular lipids and the remaining 58% was present in the water-soluble fraction of the cell, primarily as phosphorylcholine. The spin-lattice relaxation time (T_1) of this pool of phosphorylcholine indicates an intracellular viscosity approximately 1.2 times that of H_2O. Cells fixed with formaldehyde and washed several times did not exhibit ^{13}C resonances corresponding to free choline or phosphorylcholine and were sufficiently stable to be studied up to 43°C. The T_1 and line width behavior of the methyl resonance was studied as function of temperature in the fixed cells. The T_1 data exhibited an Arrhenius dependence with an activation energy of 4.3 kcal/mol, similar to that observed for free choline. The line width does not conform to an Arrhenius law and the values obtained for the CHO cells are similar to those previously reported for sonicated lecithin vesicles and to the value obtained in sonicated lecithin vesicles prepared from the extracted CHO cell lipids. The values are significantly smaller than the values reported for unsonicated lecithin dispersions. The data are discussed in terms of a theoretical model involving multiple internal rotations. A measurement of the ^{13}C—^{1}H nuclear Overhauser enhancement for the choline methyl carbons in vesicles prepared from the extracted CHO cell lipids gave a value of 3.0 +- 0.3.

25354 Plurality of pressure-denatured forms in chymotrypsinogen and lysozyme. Li, T.M.; Hook, J.W. III; Drickamer, H.G.; Weber, G. (Univ. of Illinois, Urbana). Contract E(11-1)-1198. *Biochemistry;* **15**: No. 25, 5571-5580(14 Dec 1976).

The ultraviolet fluorescence of lysozyme shows a two-step decrease in efficiency when the pressure of the solution is raised from 10^{-3} to 11 kbars. The fluorescence of chymotrypsinogen decreases smoothly in a single step confined to the region below 8 kbars, with a midpoint at 5.8 kbars. At 11 kbars, lysozyme binds 1 mol of 8-anilino-1-naphthalenesulfonate (ANS) with a dissociation constant = 4.8 μM. fluorescencehymotrypsinogen binds 2 mol with a dissociation constant = 14 μM and Hill coefficient close to unity. In both proteins, binding of ANS is confined to the region above 6 kbars. In lysozyme it roughly corresponds to the second step of ultraviolet fluorescence changes. In chymotrypsinogen it has only minimal overlap with the region of protein-fluorscence change. The existence of two distinct regions of change of ultraviolet fluorescence in lysozyme and the disparity of the regions of change of protein fluorescence and of ANS binding in the two cases demonstrate the existence of a plurality of pressure-denatured forms in both proteins. On addition of tri-N-acetyl-D-glucosamine ((N—Ac—$GlcN)_3$) to lysozyme, the two-step change of fluorescence with pressure is replaced by a smooth change in a single step with a midpoint at 5.3 kbars. Analysis of the reciprocal effects expected between ligand binding and denaturation indicates that (N—Ac—$GlcN)_3$ binds preferentially to the denatured form of the protein. The standard free energy of binding to this form is estimated to be some 3 kcal/mol higher than the free energy of binding to the native enzyme. Computation of the spectroscopic effects expected in a protein with independent pressure-denaturable domains shows that an apparent one-step change will be observed in all but extreme cases and that the volume changes calculated from the experimental data can grossly underestimate the change in volume upon denaturation of the whole protein.

25355 Study of abnormal plasma low-density lipoprotein in rhesus monkeys with diet-induced hyperlipidemia. Fless, G.M.; Wissler, R.W.; Scanu, A.M. (Univ. of Chicago). *Biochemistry;* **15**: No. 26, 5799-5805(28 Dec 1976).

Male rhesus monkeys were divided into three groups: five were fed a regular primate chow diet and were used as controls; four received an "average" American diet; and five a special low-fat primate chow diet supplemented with 25 percent coconut oil and 2 percent cholesterol. In all of these animals, the plasma low-density lipoproteins (LDL) were isolated by ultracentrifugal flotation between densities of 1.019 and 1.050 g/ml. The LDL of the five control monkeys had variable molecular weights, with a mean value of 3.12 +- 0.21 x 10^6 (range: 2.92 x 10^6 to 3.45 x 10^6), and an average partial specific volume of 0.969 +- 0.003 ml/g; both were assessed by flotation equilibrium analysis in the analytical ultracentrifuge. In the individual animals, however, the physical properties of LDL were invariant with time. The administration of either an "average" American diet or a coconut oil-cholesterol diet was accompanied by hypercholesterolemia associated with changes in LDL which were characterized by increases in molecular weight to 3.52 +- 0.21 x 10^6 (average of nine monkeys) and in partial specific volume to 0.973 +- 0.002 ml/g.

25356 Purification and properties of Renilla reniformis luciferase. Matthews, J.C.; Hori, K.; Cormier, M.J. (Univ. of Georgia, Athens). *Biochemistry;* **16**: No. 1, 85-91(11 Jan 1977).

Luciferase from the anthozoan coelenterate Renilla reniformis (Renilla luciferin:oxygen 2-oxidoreductase (decarboxylating), EC 1.13.12.5.) catalyzes the bioluminescent oxidation of Renilla luciferin producing light (lambda/sub B/ 480 nm, Q/sub B/ 5.5 percent), oxyluciferin, and CO_2. Using a combination of ion-exchange, molecular-sieve, sulfhydryl-exchange, and affinity chromatography, luciferase has been purified, approximately 12,000-fold with 24 percent recovery, to homogeneity as judged by analysis with disc and sodium dodecyl sulfate-polyacrylamide gel electrophoresis, gel filtration, and ultracentrifugation. Renilla luciferase is active as a nearly spherical single polypeptide chain monomer of 3.5 x 10^4 daltons having a specific activity of 1.8 x 10^{15} hvs^{-1} mg^{-1} and a turnover number of 111 μmol min^{-1} μmol^{-1} of enzyme. This enzyme has a high content of aromatic and hydrophobic amino acids such that it has an epsilon/sub 280 nm/ 0.1 percent/ of 2.1 and an average hydrophobicity of 1200 cal $residue^{-1}$. The high average hydrophobicity of luciferase, which places it among the more hydrophobic proteins reported, is believed to account, at least in part, for its tendency to self-associate forming inactive dimers and higher molecular weight species.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 25156

CYTOLOGY

25357 Cytochemical and radioautographic analysis of erythropoiesis at the ultrastructural level. Rosse, C.; Trotter, J.A. (Univ. of Washington, Seattle). *Am. J. Anat.;* **141**: No. 1, 41-72(Sep 1974).

The morphogenetic events of erythroid differentiation in guinea pig bone marrow were studied by electron microscopy. The diaminobenzidine (DAB) reaction and radioautographic detection of Fe^{55} incorporation permitted a more objective identification of erythroid cells than was possible in previous studies. With the combined use of these two methods morphological events of cell maturation could be correlated reliably with cytoplasmic hemoglobin content, thus providing a basis for the description of various maturation stages. The oxidation of DAB by hemoglobin coupled with OsO_4 treatment results in a generalized increase in cytoplasmic electron opacity proportional to the amount of hemoglobin present. Measurements of cytoplasmic density were carried out on electron microscopic negatives of DAB-reacted specimens that were not stained otherwise. Only those cells were regarded as erythroblasts in which the cytoplasm was at least twice as dense as in recognizable, differentiated, non-erythroid cells, using reticular cell cytoplasm in each specimen as the base line for the comparisons. In bone marrow cells, iron incorporation occurred overwhelmingly for hemoglobin synthesis.The morphological characteristics of each of the maturation stages are described with particular emphasis on the earliest erythroid cells, since the methods employed permit their identification with greater degrees of discrimination and objectivity than is possible with the light microscope or with conventional methods of electron microscopy.

25358 Survival of frozen-thawed human red cells as a function of cooling and warming velocities. Miller, R.H.; Mazur, P. (Oak Ridge National Lab., TN). *Cryobiology;* **13**: 404-414(1976).

Human red cells were equilibrated for 30 min at 20°C in buffered saline containing 2M glycerol and then frozen to —196°C at 0.27, 1.7, 59, 180, 480, 600, and 1300°C/min and warmed at 0.47, 1, 26, 160, and 550°C/min. Cells frozen at 600 and 1300°C/min responded in the classical fashion for cells containing intracellular ice; i.e., survivals were low when warming was slow (<10%), but increased progressively with increasing warming rate. The sensitivity to slow warming presumably reflects the recrystallization of intracellular ice. Cells frozen at 59 and 180°C/min yielded high survivals at all warming rates. This response is also consistent with the findings for other cells cooled just slowly enough to preclude intracellular ice. Cells frozen very slowly at 0.27 and 1.7°C/min, however, responded differently; survivals were considerably higher when warming was slow (0.47 or 1°C/min) than when it was 26, 160, or 550°C/min. This response is analogous to that observed recently by others in mouse embryos and in higher plant tissue-culture cells and to that observed for many years in higher plants. It also confirms previous observations of Meryman in human red cells. It may reflect osmotic shock from rapid dilution but, if so, the basis of the osmotic shock is uncertain.

25359 Ultrastructural features of chromatin ν bodies. Olins, A.L.; Senior, M.B.; Olins, D.E. (Oak Ridge National Lab., TN). *J. Cell Biol.;* **68**: 787-793(1976).

Spread chromatin fibers and isolated chromatin fragments prepared from chicken erythrocyte nuclei were stained with dilute aqueous uranyl acetate. High-resolution electron micrographs reveal two new morphological features exhibited by many of the chromatin ν bodies: lateral association of the ν body with the connecting strand, and a centrally stained spot ~15 A wide, possibly corresponding to a hole or crevice within the ν body.

GENETICS

REFER ALSO TO CITATION(S) 25326, 25349, 25445

25360 (CONF-760743—1) **Validation of the in vivo somatic mutation method in the mouse as a prescreen for germinal point mutations.** Russell, L.B. (Oak Ridge National Lab., Tenn. (USA)). 1976. Contract W-7405-ENG-26. 21p. Dep. NTIS $3.50.

From GUM meeting; Neuherberg, German, Federal Republic of (F.R. Germany) (1 Jul 1976).

The in-vivo somatic mutation method developed by us in an earlier x-ray experiment was tested for its usefulness in chemical mutagenesis work, specifically in the prescreening for germinal point mutations. In order to explore possible parallelisms, the seven compounds chosen for study, as well as the genetic markers used, were those with which large-scale specific-locus mutation-rate experiments in germcells had been conducted in the past or were in progress. From 1 to 3 dose levels were tested for each compound. On day $10^1/_2$ after copulation of C57BL females with T males, a single injection of the test compound was administered, and about 2000 offspring altogether were subsequently scored for survival, morphology, and presence of spots of various types. In accordance with our earlier results we found three types of spots: white near-midline ventral spots (WMVS) which probably result from killing of melanocyte precursor cells; spots resulting from misdifferentiation; and the remainder, which probably result from expression of the recessive by one of several mechanisms (RS). Induction of teratogenic effects, which were stage-specific rather than agent-specific, generally paralleled induction of WMVS's. Both are interpreted as resulting from cell killing. Induction of RS's did not always parallel induction of WMVS's, but roughly paralleled relative frequencies of specific-locus mutations induced in spermatogonia by the same compounds. Even though the in vivo somatic-mutation method probably detects genetic changes additional to point mutations, the results indicate that it may be a useful prescreen for germinal specific-locus mutations, provided care is taken to distinguish between the three types of spots, only one of which (RS) is indicative of expression of the recessive.

25361 (ORNL/EMIC—8) **Chemical mutagenesis: a survey of the 1974/1975 literature.** (Oak Ridge National Lab., Tenn. (USA)). Nov 1976. Contract W-7405-ENG-26;NCI-40-355-72;NIEHS-40-247-70. 311p. Dep. NTIS $9.75.

The literature on chemical mutagenesis during 1974 and 1975 is surveyed. The survey is composed of indexes including: citation index; agent index; chemical abstracts service registry number index; taxonomic index; test object index; cell type index; and author index. The various indexes are color coded.

25362 Genes on chromosome 3 of the mouse. Davisson, M.T.; Eicher, E.M.; Green, M.C. *J. Hered.;* **67**: 155-156(1976).

Since the identification of individual mouse chromosomes became possible through chromosomal banding methods, linkage groups have been assigned to all the mouse chromosomes except Chromosomes 3 and 16. We report here the location of three loci on Chromosome 3: carbonic anhydrase-1 (Car-1), carbonic anhydrase-2 (Car-2) (originally designated Pro-1 by Biddle and Petras)[1], and blebs (my). Car-1 and Car-2 are isozyme loci. The my mutation, found among the descendants of X-ray-treated mice by Little and Bagg[4], causes principally eye and toe defects[3]. This leaves only Chromosome 16 of the mouse with no assigned genes.

METABOLISM

REFER ALSO TO CITATION(S) 25310, 25477, 25480

25363 (COO—2502-10) **Heat transfer and thermoregulation in the largemouth blackbass (Micropterus salmoides).** Erskine, D.J.; Spotila, J.R. (State Univ. Coll., Buffalo, N.Y. (USA)). 1976. Contract EY-76-S-02-2502. 22p. (CONF-7606122—1). Dep. NTIS $3.50.

From 27. annual AIBS meeting; New Orleans, Louisiana, United States of America (USA) (Jun 1976).

We have approached the problem by examining temperature response from the viewpoint of the effects of the physical environment on the fish. Instead of focusing on the physiological processes within the organism we began by considering the constraints placed on the internal processes of the fish by its physical environment. Our objective was to define the mechanisms of heat exchange between a

freshwater fish and its environment and thereby describe the steady-state energy balance for the fish. In this study we derived a heat energy budget equation for a fish and made experimental determinations of heat transfer coefficients for fish in still and moving water.

25364 Cell-mediated cytotoxicity to Moloney sarcoma in syngeneic and allogeneic rats. Veit, B.C.; Feldman, J.D. (Scripps Clinic and Research Foundation, La Jolla, CA). *Int. J. Cancer;* **15**: 367-376(1975).

Cell-mediated cytotoxicity in the primary immune response to Moloney sarcoma tumor (MST) in allogeneic and syngeneic rats was found to be predominantly T-cell-dependent. A minor non-T-cell cytotoxic activity may also have been detected. CMC was presumably directed against tumor and viral related antigens in the syngeneic host and primarily against alloantigens in the allogeneic host. CMC was more vigorous in the allogeneic recipient than in the syngeneic host. This may be due to differences in quantities or immunogenicities of the various antigens involved. Two peaks of T-cells in effector populations were observed during a 20-day post-inoculation period. The first peak corresponded to peak T-cell-mediated cytotoxicity on day 8 and the second peak occurred on days 13 or 14 when CMC was minimal or undetectable.

25365 Feeding, growth, and food conversion of the marine planktonic copepod Calanus helgolandicus. Paffenhoefer, G.A. (Univ. of California, San Diego). *Limnol. Oceanogr.;* **21**: No. 1, 39-50(Jan 1976).

Food intake, growth rate, and food conversion of nauplii, copepodids, and adult females of Calanus helgolandicus were investigated experimentally at 15°C. The diatom Lauderia borealis and the dinoflagellates Gonyaulax polyedra, Gymnodinium splendens, and Prorocentrum micans were offered separately as food at concentrations ranging from 41 to 101 μg C liter^{-1}. Amounts of food ingested differed with concentration and species. Daily exponential growth rates were highest for nauplii and young copepodids (k = 0.29 to 0.41) and decreased gradually with increasing age of the copepods to k = 0.02. Gross growth efficiency changed during the different juvenile life periods of the copepod with maximum values for the period CdI to CIII. Feeding on L. borealis at lower food concentrations resulted in an increase in gross growth efficiency. (auth)

25366 Alkalinity changes generated by phytoplankton growth. Brewer, P.G.; Goldman, J.C. (Woods Hole Oceanographic Institution, MA). *Limnol. Oceanogr.;* **21**: No. 1, 108-117(Jan 1976).

Continuous cultures of three marine phytoplankton species, Phaeodactylum tricornutum, Dunaliella tertiolecta, and Monochrysis lutheri, were monitored for changes in alkalinity of the culture medium resulting from NO_3p and NH_4i uptake. Uptake of NO_3p caused an increase in alkalinity, whereas uptake of NH_4i produced a decrease. These results are consistent with the type of schematic equation proposed by Redfield, Ketchum, and Richards for photosynthetic assimilation of inorganic nitrogen, in which NO_3p uptake is balanced by OH^- production and NH_4i uptake leads to H^+ generation. These reactions suggest active uptake of nitrogen species by microbes. The exact stoichiometry of this relationship has not been demonstrated and the role of P uptake in the alkalinity change is unclear. An offset in the data, functionally equivalent to the production of some strong acid, may be due to reactions on the walls of the vessel, active uptake of cations, or extrusion of H^+ ions by the growing cells. (auth)

25367 Contribution of bacteria to standing crop of coastal plankton. Ferguson, R.L. (National Marine Fisheries Service, Beaufort, NC); Rublee, P. *Limnol. Oceanogr.;* **21**: No. 1, 141-145(Jan 1976).

Water samples were collected from coastal waters near Cape Lookout, N.C., during March 1975 for direct count of bacteria and for adenosine triphosphate (ATP) analysis. Bacteria averaged 6.6 X 10^5 cells ml^{-1} and 0.09 μ3 cell^{-1}. Bacterial carbon was 4 to 25% of the ATP estimate of total plankton carbon. (auth)

25368 Zein synthesis in maize endosperm by polyribosomes attached to protein bodies. Burr, B.; Burr, F.A. (Oak Ridge National Lab., TN). *Proc. Natl. Acad. Sci. U.S.A.;* **73**: No. 2, 515-519(Feb 1976).

The protein bodies in maize endosperm are the sites of zein deposition. They are single membrane-bound vesicles with polysomes associated with the exterior surface of the membrane. These protein bodies were isolated by sucrose density gradients and characterized by electron microscopy and polyacrylamide gel electrophoresis. Polyribosomes dissociated from the surface of the membrane by detergent treatment were placed into an amino-acid incorporating system. Based on alcohol solubility, amino-acid composition, and molecular weight distribution, the product synthesized appeared to be largely, or entirely, zein. This suggests the existence of components which are specific for the synthesis of zein at the protein body membrane surface.

25369 Calibrating duckweeds: light, clocks, metabolism, flowering. Hillman, W.S. (Brookhaven National Lab., Upton, NY). *Limnol. Oceanogr.;* **193**: 453-458(6 Aug 1976).

The roles of photoperiodism and related light-dependent and hormonal processes in plants are not well understood. Rapid growth, aquatic habit, and adaptability to axenic culture make the Lemnaceae, or duckweeds, excellent material for investigating these topics and others in which highly defined conditions or the presence of organic substances are crucial. As a major example among several that are described, recent work with one species suggests a relation between some features of carbon dioxide flux and the photoperiodic timing mechanism, thus providing a system in which the biochemical basis of the latter may be explored.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 25388

25370 Metabolism of labeled parathyroid hormone. III. Studies in rats. Neuman, W.F.; Neuman, M.W.; Sammon, P.J.; Simon, W.; Lane, K. (Univ. of Rochester, NY). *Calcif. Tissue Res.;* **18**: 251-261(1975).

A series of experiments indicated that ^{125}I-parathyroid hormone administered to the rat i.v. was deposited very rapidly in three organ systems only, bone, kidney and the liver. As indicated by increasing solubility in trichloracetic acid, the hormone seemed to be rapidly metabolized at the sites of deposition. The experiments were in part repeated employing quantitative extraction and gel filtration procedures. It was found that intact hormone predominated (82 percent) in the circulation but was cleared very rapidly: 91, 97, and 99 percent having left by 10, 30 and 60 minutes respectively after injection. The intact hormone was found at 10 minutes to be principally in kidney, bone, and liver. Although there was evidence of fragmentation preferentially to polypeptides of molecular weights of 6000, 45000 and 2500 these cannot be claimed to represent real molecular entities. By one hour, only a few percent of the injected hormone remained intact, the bulk having been degraded to fragments of small molecular weight.

25371 Metabolism of labeled parathyroid hormone. IV. Autoradiographic studies. Neuman, W.F.; Neuman, M.W.; Sammon, P.J.; Casarett, G.W. (Univ. of Rochester, NY). *Calcif. Tissue Res.;* **18**: 263-270(1975).

Autoradiographs were prepared from tissues of rats sacrificed 10 minutes after injection of biologically active ^{125}I-labeled parathyroid hormone. No radioactivity was seen in intestine and muscle. Deposition in liver was diffuse showing some sinusoidal concentrations. Deposition in kidney was high and, nearly all activity appeared in selected tubules (presumably proximal tubules) in the outer third of the cortex. Specific localization was also seen in bone particularly in the cellular layers of periosteum and endosteum adjacent to bony matrix and to some extent in osteocytes.

25372 Metabolism of labeled parathyroid hormone. V. Collected biological studies. Neuman, W.F.; Neuman, M.W.; Lane, K.; Miller, L.; Sammon, P.J. (Univ. of Rochester, NY). *Calcif. Tissue Res.;* **18**: 271-287(1975).

Biologically active ^{125}I-labeled parathyroid hormone (^{125}I-PTH) was used in a series of studies in dogs and chickens designed to confirm and augment earlier studies in rats. As in rats, a three exponential equation was required to describe disappearance of ^{125}I-PTH from the blood in the dog. The first two "half-lives" (1.8 and 7 min) accounted for the bulk of the dose. Also as in rats, deposition of apparently intact hormone took place rapidly in kidney, liver and bone in both the dog and the chicken. Degradation occurred very rapidly in all three target organs. Three labeled hormones of different biological activities were compared in the rat. Inactive, oxidized hormone was rejected by the liver but showed markedly increased deposition in kidney and the higher the purity of the hormone the higher was its uptake by liver. Exploration of a wide range of dosages revealed few effects on distribution (smaller depositon in liver and kidney at highest dosages, 65 μg/rat). Fresh sera did not degrade hormone rapidly or extensively. There was no deposition of hormone in intestinal mucosa, marrow, and red cells. Nephrectomy increased deposition in liver and bone. Finally, the perfused liver was capable of extensive degradation of the hormone.

25373 Metabolism of labeled parathyroid hormone. VI. Effects of vitamin D status. Neuman, M.W.; Neuman, W.F.; Lane, K. (Univ. of Rochester, NY). *Calcif. Tissue Res.;* **18**: 289-295(1975).

Labeled ^{12}I-PTH with full biological activity was utilized to investigate the interrelationship between vitamin D and parathyroid hormone (PTH) function. The distribution of labeled PTH was studied in rats and chickens on diets containing various amounts of vitamin D and calcium. The effects of vitamin D deficiency were found to be minor. There was a slightly delayed (10 to 30 percent) blood clearance of the hormone and a smaller depostion in the liver (20 to 30 percent) in the D-deficient animals. Deposition in bone and kidney appeared to be essentially normal. It is concluded that any failure of PTH to evoke a bone response in the deficient animal is not due to the failure of binding of hormone at the target organ.

25374 Studies on nitrosamine metabolism. I. Subcellular distribution of radioactivity in tumor-susceptible tissues of RFM mice following administration of [^{14}C]dimethylnitsamine. Daugherty, J.P.; Clapp, N.K. (Oak Ridge National Lab., TN). *Life Sci.;* **19**: No. 2, 265-272(1976).

The distribution of radioactivity in tumor-susceptible (liver and lung) and non-tumor-susceptible (heart, forestomach, and esophagus) tissues of male RFM mice was investigated at timed intervals following a single intragastric administration of ^{14}C-labeled DMN. The greatest amount of radioactivity was associated with the tumor-susceptible tissues - liver and lung. At 15 min, the relative amount of radioactivity in the homogenates of heart, forestomach, esophagus, liver, and lung was 1, 2, 3, 10, and 70, respectively. The AS components of lung contained about six times as much radioactivity as the liver 15 min after administration; at 16 hr, the level of radioactivity had decreased and was equal in amount. The AI components of both tumor-susceptible tissues incorporated much less radioactivity than the AS components, indicating that only a small amount of methyl label is covalently bound to cellular macromolecules. The amount of radioactivity in the AI components ranged from 2 to 34% in the lung and from 11 to 33% in the liver. In the lung C-fraction the range of radioactivity was 75 to 89% for the AS components and 52 to 74% for the AI components. The radioactivity in the AS components of liver C-fraction ranged from 50 to 89%, and from 52 to 68% for the AI components. The results suggest differences in the affinity, transport, and/or metabolism of DMN between liver and lung, as well as between tumor-susceptible and non-tumor-susceptible tissues.

MEDICINE

REFER ALSO TO CITATION(S) 24141, 25713

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 25244

25375 (CONF-770101—1) **Five and eight image tomography.** Bell, P.R.; Dillon, R.S. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 14p. Dep. NTIS $3.50.

From 7. symposium on sharing of computer programs and technology in nuclear medicine; Atlanta, Georgia, United States of America (USA) (16 Jan 1977).

This method can be implemented with standard equipment and only requires images with the usual total count and time. The time for image reconstruction is negligible since 6 slices are reconstructed in 40 seconds. While the resolution in the slices is relatively poor, it is sufficient for the location of emitting structures shown in the standard views.

25376 (LBL—4785) **Development of positron emitting radionuclides for imaging with improved positron detectors.** Yano, Y. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1976. Contract W-7405-ENG-48. 22p. (CONF-761060—7; IAEA-SM—210/123). Dep. NTIS $3.50.

From IAEA symposium on medical radionuclide imaging; Los Angeles, California, United States of America (USA) (25 Oct 1976).

Recent advances in positron cameras and positron ring detectors for transverse section reconstruction have created renewed interest in positron emitting radionuclides. This paper reports on: generator-produced ^{82}Rb; cyclotron-produced ^{62}Zn; and reactor-produced ^{64}Cu. Investigation of the ^{82}Sr (25 d)—^{82}Rb (75 s) generator determined the elution characteristics for Bio-Rex 70, a weakly acidic carboxylic cation exchanger, using 2% NaCl as the eluent. The yield of ^{82}Rb and the breakthrough of ^{82}Sr were determined for newly prepared columns and for long term elution conditions. Spallation-produced ^{82}Sr was used to charge a compact ^{82}Rb generator to obtain multi-millicurie amounts of ^{82}Rb for myocardial imaging. Zinc accumulates in the islet cells of the pancreas and in the prostate. Zinc-62 was produced by protons on Cu foil and separated by column chromatography. Zinc-62 was administered as the amino acid chelates and as the $ZnCl_2$ to tumor and normal animals. Tissue distribution was determined for various times after intravenous injection. Pancreas-liver images of ^{62}Zn-histidine uptake were obtained in animals with the gamma camera and the liver uptake of /sup 99m/Tc sulfur colloid was computer subtracted to image the pancreas alone. The positron camera imaged uptake of ^{62}Zn-histidine in the prostate of a dog at 20 h. ^{64}Cu was chelated to asparagine, a requirement of leukemic cells, and administered to lymphoma mice. Uptake in tumor and various tissues was determined and compared with the uptake of ^{67}Ga citrate under the same conditions. ^{64}Cu-asparagine had better tumor-to-soft tissue ratios than ^{67}Ga-citrate.

25377 (LBL—4794) **Emission computed axial tomography.** Budinger, T.F.; Derenzo, S.E.; Gullberg, G.T.; Greenberg, W.L.; Huesman, R.H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1976. Contract W-7405-ENG-48. 28p. (CONF-761060—6; IAEA-SM—210/124). Dep. NTIS $3.50.

From IAEA symposium on medical radionuclide imaging; Los Angeles, California, United States of America (USA) (25 Oct 1976).

Computed transverse section emission tomography using /sup 99m/Tc with the Anger camera is compared to positron annihilation coincident detection using a ring of crystals and ^{68}Ga. It is concluded that positron computed section imaging has a tenfold increase in sensitivity over multiple-view imaging with the gamma camera which gives multiple sections but requires camera or patient rotation.

25378 (LBL—4797) **High resolution computed tomography of positron emitters.** Derenzo, S.E.; Budinger, T.F.; Cahoon, J.L.; Huesman, R.H.; Jackson, H.G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1976. Contract W-7405-ENG-48;NCI-G-ROI-CA-17566-01;NCI-NIH-YOI--CB-50304. 17p. (CONF-761006—28). Dep. NTIS $3.50.

From Nuclear science, scintillation and semiconductor counter symposium; New Orleans, Louisiana, United States of America (USA) (20 Oct 1976).

High resolution computed transaxial radionuclide tomography has been performed on phantoms containing positron-emitting isotopes. The imaging system consisted of two opposing groups of eight NaI(Tl) crystals 8 mm x 30 mm x 50 mm deep and the phantoms were rotated to measure coincident events along 8960 projection integrals as they would be measured by a 280-crystal ring system now under construction. The spatial resolution in the reconstructed images is 7.5 mm FWHM at the center of the ring and approximately 11 mm FWHM at a radius of 10 cm. We present measurements of imaging and background rates under various operating conditions. Based on these measurements, the full 280-crystal system will image 10,000 events per sec with 400 μCi in a section 1 cm thick and 20 cm in diameter. We show that 1.5 million events are sufficient to reliably image 3.5-mm hot spots with 14-mm center-to-center spacing and isolated 9-mm diameter cold spots in phantoms 15 to 20 cm in diameter.

MICROBIOLOGY

25379 New species of RNA formed during tobacco mosaic virus infection. Siegel, A.; Hari, V.; Montgomery, I.; Kolacz, K. (Wayne State Univ., Detroit). *Ann. Microbiol. (Paris);* **127A**: No. 35, vp(1976).

Previous investigations have demonstrated that extracts of TMV infected leaf tissue contain several unique virus related RNA species, including viral RNA, RF, RI and a low-molecular-weight component (LMC) of approximately 2.5 x 10^5 daltons. We have found that LMC becomes heavily labelled when infected tissue is incubated in the dark in the presence of actinomycin D and ^{3}H-uridine. This component was isolated by sucrose-density gradient centrifugation and polyacrylamide gel electrophoresis and was used as a messenger in a wheat-germ derived cell-free protein synthesizing system. Analysis of the products produced by SDS-gel electrophoresis revealed a protein the same size as TMV coat protein. It was confirmed as coat protein by its reaction with specific antiserum in a gel-diffusion test. We conclude that LMC acts as a messenger for coat protein in the in vitro system and deduce that it probably does so in vivo. During the course of isolating LMC, we have observed several previously unreported new RNA species, probably unique to infected tissue. Among these are a component of approximately 1.1 x 10^6 daltons and another of a size similar to that of, but distinct from, viral RNA. There are indications that other unique RNA species may also be present and evidence for these will be presented. Our evidence to date points to the likelihood that TMV RNA may be processed into smaller pieces for translation rather than, as in the case of poliovirus, being translated into a polyprotein. It is possible that other groups of non-split genome plant viruses may behave in manner similar to that of TMV in this regard. We have observed that tobacco etch virus (a member of the Pot Y group) infected tissue also contains a component similar to that of LMC but larger (ca. 350,000 daltons). A peculiar feature of this system is that it appears to be sensitive to actinomycin D.

25380 Role of Escherichia coli dnaA gene and its integrative suppression in M13 Coliphage DNA synthesis. Mitra, S.; Stallions, D.R. (Oak Ridge National Lab., TN). *Eur. J. Biochem.;* **67**: 37-45(1976).

An F^+ derivative of Escherichia coli E508 thermosensitive in dnaA function (involved in DNA synthesis initiation), its revertant and an Hfr derivative of E508(ts) in which the temperature-sensitive phenotype is suppressed by integrative suppression have been compared for their ability to support M13 phage DNA synthesis at the nonpermissive temperature. Upon infection at the nonpermissive temperature, both the revertant and the Hfr strain support normal phage replication while the temperature-sensitive mutant does not.

However, when infection is carried out at a permissive temperature and the temperature is shifted up after infection, phage synthesis occurs in the temperature-sensitive mutant also, but in lesser quantity than in the revertant strain. Analysis of intracellular labeled phage DNA indicates: (a) parental replicative form DNA synthesis is not dependent on dnaA function; (b) progeny replicative form DNA synthesis is strongly inhibited in the temperature-sensitive dnaA mutant at the nonpermissive temperature; (c) progeny single-strand DNA synthesis does not absolutely require dnaA function; (d) progeny single-strand DNA is present in the circular form. The implication of the host DNA replication in M13 DNA synthesis is discussed.

25381 Role of Escherichia coli dnaG function in coliphage M13 DNA synthesis. Dasgupta, S.; Mitra, S. (Oak Ridge National Lab., TN). *Eur. J. Biochem.;* 67: 47-51(1976).

Examination of the role of Escherichia coli dnaG function in different stages of M13 phage DNA synthesis by ultracentrifugal analysis of intracellular phage DNA in a thermosensitive dnaG mutant shows that: (a) the formation of parental double-strand replicative-form DNA (rfDNA) from the infecting virus is independent of dnaG function; (b) the synthesis of progeny rfDNA requires dnaG product; (c) after a pool of rfDNA is made up, dnaG function is not required for the progeny single-strand DNA (ssDNA) synthesis. The ssDNAs produced under nonpermissive condition are mostly circular and biologically functional.

25382 Lack of a unique termination site for the first round of bacteriophage lambda DNA replication. Valenzuela, M.S. (Brandeis Univ., Waltham, MA); Freifelder, D.; Inman, R.B. *J. Mol. Biol.;* 102: 569-589(1976).

From previous data on the first round of bacteriophage lambdacIIcIII DNA replication (Schnos and Inman, 1970) it is possible to estimate, by extrapolation, the position on circular lambda DNA where bidirectional growing points meet. In the present study we have investigated whether this position occurs at a genetically defined site. To this end, replicative intermediates of lambda mutants containing either deletions to the left of the replication origin, or one deletion plus a duplication to the right, were analyzed in the electron microscope. Our results indicate that (i) leftward growing points can traverse the extrapolated termination point calculated from the lambdacIIcIII data, (ii) no discontinuity of either right or leftward growing fork position is observed, and (iii) the extrapolated termination points for these mutants are well removed from those calculated for lambdacIIcIII DNA. From these data we conclude that there is probably no unique termination site for the first round of lambda DNA replication and that termination occurs simply by collision of the growing forks.

25383 Replication of mycoplasmavirus MVL51: attachment of MVL51 parental DNA to host cell membrane. Das, J.; Maniloff, J. (Univ. of Rochester, NY). *Proc. Natl. Acad. Sci. U.S.A.;* 73: No. 5, 1489-1493(May 1976).

The replication of the single-stranded circular DNA of MVL51 mycoplasmavirus has been studied with respect to the roles of free and membrane-associated viral DNA intermediates. Replication involves the formation of parental replicative intermediate (RF) molecules on, at most, two to three membrane sites per cell, symmetric RF replication at the membrane, and apparent asymmetric RF replication in the cytoplasm leading to single-stranded progeny chromosomes.

25384 Replication of mycoplasmavirus MVL51. IV. Inhibition of viral synthesis by rifampin. Das, J.; Maniloff, J. (Univ. of Rochester, NY). *J. Virol.;* 18: No. 3, 969-976(Jun 1976).

The effect of rifampin on the replication of MVL51, a bullet-shaped mycoplasmavirus with single-stranded circular DNA of molecular weight 2 x 10^6, has been examined in a rifampin-resistant host cell. Rifampin does not block the early steps in MVL51 infection but does decrease the total amount of parental viral DNA taken up. The single-stranded parental viral DNA that enters the cell is found in membrane-associated, double-stranded DNA replicative forms I and II. Rifampin had no significant effect on the synthesis of progeny viral DNA RFI and RFII early in infection and SSI (single-stranded progeny viral chromosomes) later in infection. The rifampin block in virus synthesis was found to be in the step converting SSI into assembled virions. Rifampin was shown to affect the synthesis of virus-specific RNA, which suggests that viral transcription is necessary for virion assembly.

PATHOLOGY

25385 (COO—2401-67) Cellular proliferation and regeneration following tissue damage. Progress report. Harding, C.V. (Wayne State Univ., Detroit, Mich. (USA). Kresge Eye Inst.). Oct 1976. Contract EY-76-S-02-2401. 71p. Dep. NTIS $4.50.

Results are reported from a study of wound healing in tissues of the eye, particularly lens, cornea, and surrounding tissues. The reactions of these tissues to mechanical injuries, as well as injuries induced by chemotoxic agents were studied. It is postulated that a better understanding of the basic reactions of the eye to injurious agents may be of importance in the evaluation of potential environmental hazards.

25386 Acidification of plasma by the red cell due to radiographic contrast materials. Lichtman, M.A.; Murphy, M.S.; Whitbeck, A.A.; Pogal, M.; Lipchik, E.O. (Univ. of Rochester, NY). *Circulation;* 52: 943-950(Nov 1975).

The effect of water-soluble radiographic contrast material on pH when added to blood in clinical dosages in vitro or when used in vivo for diagnostic purposes was examined. Contrast material caused a reduction of blood pH. The mechanism of this occurence was found to be the balancing of the negative charge of intracellular organic anions by the extracellular anionic contrast material molecules. The normal negative potential of about 10 mV across the red cell membrane was reduced, nullified, or reversed depending on the concentration of contrast material added to blood. As the inside of the cell became more positive with respect to the outside, protons were, in effect, repelled into plasma, although the apparent exodus of protons occurs by the generation and outward diffusion of carbon dioxide. Since the acidemia is dependent on rehydration of carbon dioxide in plasma, a reaction measured in seconds, the site of injection and transit time of dye will contribute to the pH of the plasma during passage through a regional capillary bed. We speculate that an alteration in membrane potential and/or the acute acidemia may contribute to the adverse effects of contrast material, particularly on tissues dependent on membrane electrical rhythmicity such as the myocardium.

PHYSIOLOGICAL SYSTEMS

REFER ALSO TO CITATION(S) 25385

25387 (BNL—21785) Observations on the regulation of granulocytopoiesis. Cronkite, E.P.; Burlington, H.; Chanana, A.D.; Joel, D.D.; Stevens, J.; Reincke, U. (Oak Ridge National Lab., Tenn. (USA)). 2976. Contract E(30-1)-16. 22p. (CONF-760960—2). Dep. NTIS $3.50.

From 16. international congress of hematology; Kyoto, Japan (5 Sep 1976).

The following topics are discussed: current concept of the structure of hemopoiesis; a deterministic model of granulocytopoiesis in man; influence of sterile inflammation upon kinetics of granulocytopoiesis; studies on granulopoiesis after inoculation of a granulocytosis-producing tumor in the mouse; in vivo effects of inoculation of granulocytosis-producing tumor; and working hypothesis on regulation of granulopoiesis. (HLW)

25388 Metabolism of labeled parathyroid hormone. II. Methodological studies. Neuman, W.F.; Neuman, M.W.; Sammon, P.J.; Lane, K. (Univ. of Rochester, NY). *Calcif. Tissue Res.;* 18: 241-250(1975).

Further studies on the preparation of ^{125}I-labeled, biologically active parathyroid hormone have resulted in improvements in the procedure, in the storage of the labeled product, and in the establishment of the location of the label in the polypeptide chain. Approximately 95 percent of the label is on the single tyrosyl residue, amino acid 43, in the bovine hormone. New procedures have also been developed for the isolation and quantitative gel filtration of the labeled hormone deposited in tissues (liver, kidney and bone).

25389 Effects of temperature on food ingestion rate and absorption, retention, and equilibrium burden of phosphorus in an aquatic snail, Goniobasis clavaeformis Lea. Elwood, J.W.; Goldstein, R.A. (Oak Ridge National Lab., TN). *Freshwater Biol.;* 5: 397-406(1975).

The effects of sublethal temperatures on feeding rates and phosphorus dynamics of a freshwater snail, Goniobasis clavaeformis Lea, were determined and feeding rates were measured at four temperatures. The food source was aufwuchs labelled with radioactive phosphorus. A model was developed to elucidate the results of this type of study. Food ingestion rate increased with increasing temperature up to 14°C and then decreased at temperatures above 14°C. The elimination rate of absorbed phosphorus increased with increasing temperature throughout the entire range of experimental temperatures, 10 to 19.3°C. Mean retention times of absorbed phosphorus in Goniobasis were estimated to be 34, 24, 10, and 6 days at 10, 13.8, 15, and 19.3°C, respectively. Mean retention time of unabsorbed ^{32}P in the gut of this species as a function of temperature followed the same temperature relationship as that of ingestion rate. The absorption efficiency of phosphorus was estimated to be constant at about 39 percent for all experimental temperatures, although the data suggest that the absorption efficiency may have been related inversely to the rate of gut clearance or directly to the residence time of food in the gut. The equilibrium body load of phosphorus at each experimental temperature was estimated based on concentra-

tions of stable phosphorus in the food source and the kinetics of ^{32}P in Goniobasis. The equilibrium body burden of phosphorus in Goniobasis increased with increasing temperatures up to a maximum at 11 to 12°C and then decreased at temperatures above 12°C.

25390 Regulation of enzymes of serine and one-carbon metabolism by testosterone in rat prostate, liver, and kidney. Sanborn, T.A.; Kowle, R.L.; Sallach, H.J. (Univ. of Wisconsin, Madison). Contract E(11-1)-1631. *Endocrinology;* **97**: No. 4, 1000-1007(Oct 1975).

A significant decrease in the specific activity of 3 enzymes of serine and one-carbon metabolism (3-phosphoglycerate dehydrogenase, phosphoserine phosphatase, and serine hydroxymethyltransferase) was found in the rat prostate gland with castration. A single injection of testosterone propionate to rats 3 days after castration resulted in a significant increase in the 3 enzyme activities within 24 h. This increase in specific activity was maximal 72 h after injection of testosterone in the case of 3-phosphoglycerate dehydrogenase and serine hydroxymethyltransferase. When cycloheximide was administered in conjunction with testosterone, the increase in 3-phosphoglycerate dehydrogenase and serine hydroxymethyltransferase activity was significantly reduced compared to injection of testosterone alone. N^6,O^2w-dibutyryl adenosine-3',5'-cyclic monophosphate [$(Bu)_2$ cAMP] and theophylline injected at 8 h intervals to rats 3 days after castration failed to mimic the action of testosterone on these 3 enzymes 24 and 72 h after beginning injections. Castration had no effect on the specific activity of these enzymes in the kidney; however, 3-phosphoglycerate dehydrogenase was significantly diminished in the liver 6 days after castration. A single injection of testosterone to rats 3 days after castration restored the activity to sham-operated levels. Serine hydroxymethyltransferase and phosphoserine phosphatase activity in the liver were unaffected 6 days after castration. Thus testosterone exerts a regulatory role on serine and one-carbon metabolism in the prostate and liver which $(Bu)_2$ cAMP is unable to mimic.

25391 Temperature maintenance and CO_2 concentration in a swarm cluster of honey bees, Apis mellifera. Nagy, K.A.; Stallone, J.N. (Univ. of California, Los Angeles). *Comp. Biochem. Physiol., A;* **55**: 169-171(1976).

A swarm cluster of bees had a nearly constant core temperature (mean = 34.0°C) despite air temperatures that ranged from 4.0 to 16.4°C. Core CO_2 concentrations were inversely correlated with air temperatures, suggesting that the bees regulated cluster temperature by appropriate variation of their rate of heat production. Contraction of the cluster to conserve heat at the lower air temperatures was not detectable.

25392 Modified nucleosides in urine: selective removal and analysis. Uziel, M. (Oak Ridge National Lab., TN); Smith, L.H.; Taylor, S.A. *Clin. Chem.;* **22**: No. 9, 1451-1455(1976).

Because excretion of certain nucleosides increases in all types of cancer, detection and treatment of the disease would be enhanced by rapid, simple quantitation of such nucleotides. To facilitate these analyses in urine, we have prepared a specific adsorbent for nucleosides. The affinity adsorbent gel contains an immobilized phenylboronic acid group that specifically binds cis-diols, as in ribonucleosides, which can then be quantitatively recovered by elution with acetic acid. The advantage of this boronate gel over other preparations lies in its high capacity in the swollen state (0.26 mmol/ml), so that only small volumes (less than 1 ml) of gel are required for assays. Nucleosides containing a free diol group on the ribosyl group are retained at pH 8.8 in 0.25 mol/liter salt solution with a retention volume of 15 or larger, as compared with values of 1 to 2 for the free bases. Negatively charged species (not including the boronate complex) are eluted earlier than neutral or cationic species. Added nucleosides (neutral, cationic, or anionic) are quantitatively recovered. Because pseudouridine is eluted in a unique position, this property has been used to measure it in urine. The procedures used are chemically mild. For example, we have confirmed the observation of Fink and Adams [Arch. Biochem. Biophys. 126, 27 (1968)] that urine contains N^1-methyladenosine and not N^6-methyladenosine, the alkaline rearranged product.

25393 Studies on Lymphocytes XIII. Nuclear volume measurement as a rapid approach to estimate proliferative fraction. Sipe, C.R.; Chanana, A.D.; Cronkite, E.P.; Gulliani, G.L.; Joel, D.D. (Brookhaven National Lab., Upton, NY). *Scand. J. Haematol.;* **16**: 196-201(1976).

A rapid method for measuring volume distributions of human, calf and goat lymphocytes and their nuclei is described along with the type of quantitation these measurements can provide by computer analysis. The size distribution studies indicate the presence of two populations of lymphocytes and their nuclei irrespective of the cell source. It is suggested that proliferative fractions of various cell populations may be estimated by determining the nuclear volume distribution.

25394 Influence of vitamin A on the susceptibility of the rat lung to 3-methylcholanthrene. Nettesheim, P.; Williams, M.L. (Oak Ridge National Lab., TN). *Int. J. Cancer;* **17**: 351-357(1976).

The susceptibility of rats to pulmonary carcinogens is increased in the absence of vitamin A intake even when considerable amounts (0.4 nmole/mg) of vitamin A are stored in the liver and deficiency symptoms are absent. This was demonstrated in studies on the induction of metaplastic lung nodules by intratracheally administered 3-methylcholanthrene. Only moderate amounts of all-trans-retinyl acetate in the diet (7.6 nmole/g of diet) were required to prevent the development of this state of enhanced susceptibility. A further increase in intake of retinoids (by intragastric administration of either all-trans-retinyl acetate or 13-cis-retinoic acid) provided no additional protection against the effects of carcinogen.

25395 Protein incorporation by isolated amphibian oocytes. Wallace, R.A.; Jared, D.W. (Oak Ridge National Lab., TN). *J. Cell Biol.;* **69**: 345-351(1976).

Macromolecules of vitellogenin were sequestered by Xenopus laevis oocytes 20 to 50 times (on a molar basis) more rapidly than other proteins tested. Selectivity for vitellogenin did not appear to involve molecular size or charge. The K/sub m/ for vitellogenin incorporation was at least several orders of magnitude less than that for bovine serum albumin (BSA). At concentrations less than 10 $mg.ml^{-1}$, BSA did not measurably compete with vitellogenin; a slight, apparent competition observed above a BSA concentration of 10 $mg.ml^{-1}$ was probably spurious. Above a concentration of 2 $mg.ml^{-1}$, vitellogenin promoted $Bml^{-1}A$ incorporation by about 40 percent. These results are consistent with the notion that vitellogenin binds to specific receptor sites on the oocyte membrane and is subsequently internalized by micropinocytosis. Other proteins, such as BSA, which do not compete with vitellogenin are most likely to be incorporated by adventitious engulfment during micropinocytosis.

25396 Oogenesis in Xenopus laevis (Daudin). III. Localization of negative charges on the surface of developing oocytes. Brummett, A.R.; Dumont, J.N. (Oak Ridge National Lab., TN). *J. Ultrastruct. Res.;* **55**: 4-16(1976).

Developing oocytes and coelomic eggs of mature HCG-stimulated Xenopus females were dissected from the ovary, fixed in glutaraldehyde, and treated with a positively charged solution of colloidal iron. Electron micrographs reveal anionic sites preferentially localized in or on the plasmalemma covering the distal portions of the numerous microvilli of Stage IV oocytes. Both prior to and subsequent to Stage IV (the peak of vitellogenic activity), the anionic sites on the oolemma are more randomly distributed. No iron particles appear in endocytotic pits of the oolemma at any stage of development, but endocytotic pits of follicle cells are labeled. There are few if any anionic sites in the vitelline envelope. The assumption that the negative charges are due to sialic acid moieties of surface mucopolysaccharides was borne out by treatment with neuraminidase. Oocytes subjected to the enzyme and subsequently fixed and treated with colloidal iron show a marked reduction in the amount of labeling. These results are discussed in the light of earlier evidence regarding the endocytosis of vitellogenin, a negatively charged molecule.

25397 Characterization of DNA polymerase induced by bacteriophage T5 with DNA containing single strand breaks. Fujimura, R.K.; Roop, B.C. (Oak Ridge National Lab., TN). *J. Biol. Chem.;* **251**: No. 7, 2168-2175(1976).

DNA polymerase induced by bacteriophage T5 was purified and characterized using mainly circular duplex DNA of bacteriophage PM2 with single strand breaks formed by DNase I action. A purification procedure is described which has consistently yielded DNA polymerase preparations with only one detectable protein band after polyacrylamide gel electrophoresis of either native protein in Tris-glycine buffer or denatured protein in the presence of dodecyl sulfate. The purified polymerase preparations utilized both denatured DNA and nicked DNA as primer-templates, although at 37° the activity with denatured DNA was much greater. Polymerase activities with both kinds of primer-templates were shown to be associated with one phage-induced protein. DNA synthesis with nicked DNA as primer-template increased with increasing numbers of single strand breaks. Essentially all such breaks were repairable by ligase. Alkaline sucrose gradient centrifugation showed that synthesis occurred with the strand which had a single strand break as a primer yielding DNA longer than one phage DNA unit length. Newly synthesized DNA was covalently linked to the primer strand. Thus the synthesis very likely occurred by strand displacement; this is supported by electron micrographs shown in the Appendix.

25398 Plasma fluoride concentrations in rats acutely poisoned with sodium fluoride. De Lopez, O.H.; Smith, F.A.; Hodge, H.C. (Univ. of Rochester, NY). *Toxicol. Appl. Pharmacol.;* **37**: 75-83(1976).

Female rats of average body weight 250 g proved to be approximately twice as susceptible to the acute toxic effects of sodium fluoride given po as were female rats weighing on the average 80 or 150 g. The 24-hr oral LD50 values were 31, 54, and 52 mg of F/kg, respectively. Following single doses of 25 mg of F/kg for 250-g rats or 50 mg of F/kg for rats weighing 80 or 150 g,

absorption of fluoride from the gastrointestinal tract was approximately 50 percent complete in less than 90 min for the 250-g rats and in about 2 hr for the 80- and 150-g animals. In treated rats given 50 mg of F/kg, plasma fluoride concentrations (normally 0.3 μg/ml or less) increased to 10 μg/ml or more in 15 min in 80- or 150-g rats. Quantitatively similar increases were noted in 250-g rats given 25 mg of F/kg. Plasma fluoride concentrations of 8 to 10 μg/ml or higher were often associated with death, regardless of dose or body weight (age), but were achieved more rapidly in the heaviest rats. In surviving rats, plasma fluoride concentrations declined rapidly from maximal values reaching concentrations at 24 hr of 3 and 0.3 μg/ml, respectively, for the 150- and 250-g rats, and of approximately 4 μg/ml at 8 hr for the 80-g rats. Plasma fluoride concentrations after near lethal doses were dose-dependent. The greater resistance of the 80- and 150-g rats to the lethal effects of fluoride may reflect the greater efficiency of the younger skeletons in removing fluoride from the circulation.

25399 Distribution of viral glycoprotein gp 69/71 on cell surfaces of producer and nonproducer cells. Kennel, S.J.; Feldman, J.D. (Scripps Clinic Research Foundation, La Jolla, CA). *Cancer Res.;* **36**: 200-208(Jan 1976).

The distribution of the viral glycoprotein, gp 69/71, was studied on the cell surfaces of virus-producing and nonproducing cells. gp 69/71 was distributed evenly on cell membranes and on viral membranes of cells producing murine leukemia virus. gp 69/71 was distributed uniformly on cell membranes of thymocytes from NZB and strain 129 mice but was not detected on cell membranes of BALB/c thymocytes. Viral particles were associated with NZB and BALB/c thymocytes but were not in or on 129 thymocytes. We conclude that the presence of gp 69/71 on thymocyte membranes is not related to virus production. In the strains showing gp 69/71 on their thymocyte surfaces (NZB and 129), a large percentage of the thymocytes are positively labeled, all more or less equally. Immunochemical analysis of cell surface proteins labeled with ^{125}I corroborated the ultrastructural observations. Thus, gp 69/71 can be expressed on the surface of thymocytes independently of virus particle production.

25400 Influence of retinyl acetate on the postinitiation phase of preneoplastic lung nodules in rats. Nettesheim, P.; Cone, M.V.; Snyder, C. (Oak Ridge National Lab., TN). *Cancer Res.;* **36**: 996-1002(Mar 1976).

The effects of retinyl acetate (RA) on the development of carcinogen-induced metaplastic lung nodules were investigated. Four mg of 3-methylcholanthrene were administered intratracheally to F344 rats maintained on a vitamin A-free diet and receiving 31.4 nmoles of RA per week by intragastric intubation. At 3, 5, and 10 weeks after intratracheal instillation of 3-methylcholanthrene, one group of 24 rats each was started on a weekly dose of 31,400 nmoles of RA; a control group was continued on the low-RA dose. Fifty-two weeks after 3-methylcholanthrene injection, the incidence of metaplastic lung nodules was found to be 3 percent in the combined high-RA-dose groups as compared with 42 percent in the low-RA-dose group. It is therefore concluded that RA has a significant effect on the postinitiation phase of preneoplastic lung nodules in rats.

TRACER TECHNIQUES

25401 Preferential localization and rate of loss of labeled alloantibody from rat tumors and skin transplants carrying the corresponding alloantigen. Izzo, M.J.; Bale, W.F. (Univ. of Rochester, NY). *Cancer Res.;* **36**: 2868-2873(Aug 1976).

^{125}I-labeled rat histocompatibility antibody was prepared from sera of Buffalo rats immunized with a transplantable fibrosarcoma induced by methylcholanthrene in a Fischer 344 rat. After i.v. injection this antibody was shown to localize with high specificity in transplants of a second Fischer 344 tumor or Fischer 344 skin grafts onto immuno-suppressed Buffalo rats. These represent conditions such that only tumor or skin grafts carry the corresponding antigen. In skin transplants localization at 24 hr corresponded to 80 percent and in tumor to 30 percent of the injected dose in tissue equal to 1 percent of the rat weight. However, rapid loss of the ^{125}I label from the target tissues indicated that degradation of antibody fixed to target cells was rapid and that the half-time of the intact antibody was less than 2 days.

PUBLIC HEALTH

REFER ALSO TO CITATION(S) 25281

25402 (COO—2874-9) **Relation of air pollution to mortality: a critique.** Goldstein, I.F.; Goldstein, M.; Landovitz, L. (SIAM Inst. for Mathematics and Society, New Canaan, Conn. (USA)). 1976. Contract EY-76-S-02-2874. 16p. Dep. NTIS $3.50.

A study published in May, 1976, by Schimmel and Murawski concluded that although there is some excess in daily mortality attributable to SO_2 on the basis of regression, SO_2 itself is actually harmless, but is associated with other as yet unidentified pollutants that are the real cause of excess mortality. The conclusions are criticized in regard to the following: the use of a single air pollution station to represent the entire metropolitan area; methodological weaknesses in the linear multiple regression analysis; handling of meteorological variables; the use of daily mortality statistics to assess adverse health effects of daily levels of air pollution; and instability of populations on which the regression is based. (HZW)

25403 (COO—2874-14) **News: SIMS study on statistics and environmental factors in health.** (SIAM Inst. for Mathematics and Society, New Canaan, Conn. (USA); Stanford Univ., Calif. (USA); Columbia Univ., New York (USA)). Oct 1976. Contract EY-76-S-02-2874. 12p. Dep. NTIS $3.50.

Objectives of the SIMS study are to develop, promote, support, and maintain research and foster education in the application of mathematics to societal problems. Conferences are organized on ecosystems, energy, environmental health, and epidemiology. Activities of Columbia University include analysis of data on air pollution and health for New York City and obtaining health data from emergency room visits at four hospitals in New York City. Activities of Stanford University include development of mathematical models for analysis of pollution information. (HLW)

AGRICULTURE AND FOOD TECHNOLOGY

25404 Nitrosocarbaryl: its effect on human DNA. Regan, J.D.; Setlow, R.B.; Francis, A.A.; Lijinsky, W. (Oak Ridge National Lab., TN). *Mutat. Res.;* **38**: 293-302(1976).

Human skin cells (both normal and xeroderma pigmentosum) were treated with carbaryl (N-methyl-1-naphthyl-carbamate), a common agricultural pesticide, or its N-nitroso derivative, nitrosocarbaryl, and the DNA of the cells was sedimented in alkaline sucrose gradients at several times after treatment. Numerous single-strand breaks were apparent in the DNA of the nitrosocarbaryl-treated cells but not in the DNA of those treated with carbaryl. The nitrosocarbaryl effect on the DNA could be observed up to 20 h after removal of the chemical from the cultures. The DNA of human cells treated with ring labeled nitroso[^{3}H]carbaryl and methyl labeled nitroso [^{14}C]carbaryl was isolated and banded in cesium chloride density gradients. The peak of ^{14}C radioactivity and not the ^{3}H radioactivity coincided with the optical density peak of the human DNA from these gradients. An aliquot of the same DNA was alkaline denatured and banded on alkaline cesium chloride gradients with similar results. These observations suggest that the nitrosocarbaryl molecule is split and only the methyl containing residue forms an irreversible association with human cellular DNA, resulting in chemical changes observable as alkali-sensitive bonds.

25405 Nutrition and agricultural development. Significance and potential for the tropics. Conference held in Guatemala City, Guatemala, December 2—6, 1974. Scrimshaw, N.S.; Behar, M. (eds.). New York; Plenum Press (1976). 524p. (CONF-741264—).

From 14. Latin American symposium on nutrition and agricultural and economic development in the tropics; Guatemala City, Guatemala (2 Dec 1974).

Separate abstracts were prepared for the 40 papers presented at the conference. (HLW)

25406 Man, food, and environmental interrelationships. Brown, L.R. (Worldwatch Inst., Washington, DC). pp 3-12 of In Nutrition and agricultural development. Significance and potential for the tropics. Scrimshaw, N.S. (ed.). New York; Plenum Press (1976).

From 14. Latin American symposium on nutrition and agricultural and economic development in the tropics; Guatemala City, Guatemala (2 Dec 1974).

See CONF-741264—.

Some topics discussed are as follows: population and affluence; land, water, energy, and fertilizer as the four basic resources; ecological undermining of major food-producing systems; the long-term challenge; slowing growth in demand; production potential of poor countries; fertilizer production and distribution; managing scarcity; and complexity, change, and leadership. (HLW)

25407 Definition of the nutrition problem: poverty and malnutrition in mother and child. Moenckeberg, F. (Univ. of Chile, Santiago). pp 13-23 of In Nutrition and agricultural development. Significance and potential for the tropics. Scrimshaw, N.S. (ed.). New York; Plenum Press (1976).

From 14. Latin American symposium on nutrition and agricultural and economic development in the tropics; Guatemala City, Guatemala (2 Dec 1974).

See CONF-741264—.

Some topics discussed are as follows: prevalence of malnutrition in spite of great advances in man's knowledge; severe effects of malnutrition on infants and children; relation of socioeconomic con-

ditions to health, intelligence, and social behavior; effects of poverty on family life; effects of malnutrition on successive generations of rats; and effects of diet on intelligence, weight, and height in school children in Chile. (HLW)

25408 Microenvironmental factors in severe protein—calorie malnutrition. Cravito, J.; DeLicardie, E.R. (IMAN, Mexico City). pp 25-35 of In Nutrition and agricultural development. Significance and potential for the tropics. Scrimshaw, N.S. (ed.). New York; Plenum Press (1976).

From 14. Latin American symposium on nutrition and agricultural and economic development in the tropics; Guatemala City, Guatemala (2 Dec 1974).

See CONF-741264—.

Some topics discussed are as follows: macroenvironmental factors such as family structure, sources of family income, and sanitary facilities; microenvironmental features such as frequency of adult contact, vocal stimulation, emotional climate, and available play materials; behavioral differences in mothers of future malnourished children; and ecology of weight gain in infants living in a preindustrial village. (HLW)

25409 Perspectives and priorities in food and nutrition planning. Beaton, G.H. (Univ. of Toronto). pp 37-44 of In Nutrition and agricultural development. Significance and potential for the tropics. Scrimshaw, N.S. (ed.). New York; Plenum Press (1976).

From 14. Latin American symposium on nutrition and agricultural and economic development in the tropics; Guatemala City, Guatemala (2 Dec 1974).

See CONF-741264—.

Some topics discussed are as follows: development of planning models providing for multiple inputs and including feedback loops from the operational levels; definition of the nutrition problem; consideration of data in terms of age/sex group, geographic area, city or rural location, cultural/ethnic group, and income level; and development of indices of change. (HLW)

25410 Environment of the malnourished child. Mata, L.J. (Univ. of Costa Rica, San Jose). pp 45-66 of In Nutrition and agricultural development. Significance and potential for the tropics. S. Srimshaw, N.S. (ed.). New York; Plenum Press (1976).

From 14. Latin American symposium on nutrition and agricultural and economic development in the tropics; Guatemala City, Guatemala (2 Dec 1974).

See CONF-741264—.

The physical environment in tropical and subtropical regions, and the socioeconomic characteristics of the population inhabiting such regions, favor maintenance and transmission of a variety of viruses, bacteria, and parasites that make agricultural progress and social development difficult, and that contribute to poor fetal growth, nutrient wastage, and deficient postnatal physical growth, accounting for most of the childhood morbidity and mortality. In this regard, infections contribute indirectly to the overall food problem in a similar fashion as pests do in terms of food losses and spoilage. The overall effect could be comparable or greater than that resulting from an inadequate capacity to produce or to purchase the food needed. Thus, my objective has been to stress, within the whole environment, the importance of infection and the need to diminish it. Ways to control and prevent infection are readily known. They have to do with education of the population to improve personal and environmental hygiene. Economic investment is necessary to improve housing and water supply systems, waste disposal, and such preventive measures as immunization programs. Although such measures may appear expensive when first implemented, they have long-lasting effects and many require minimal expenditure once they are established. Large segments of the population stand to benefit, and other development interventions can then be introduced. However, these measures should not be implemented singly. They should be accompanied by community development, family planning, social legislation—in other words, the holistic approach to health and welfare. To do otherwise may aggravate the problem by stimulating demographic growth, perpetuating malnutrition and infection, and maintaining underdevelopment.

25411 Nutritional status of Latin American adults. Arteaga L., A. (Catholic Univ., Santiago). pp 67-76 of In Nutrition and agricultural development. Significance and potential for the tropics. Scrimshaw, N.S. (ed.). New York; Plenum Press (1976).

From 14. Latin American symposium on nutrition and agricultural and economic development in the tropics; Guatemala City, Guatemala (2 Dec 1974).

See CONF-741264—.

Some topics discussed are as follows: malnutrition in various age groups of the working population; small stature and other consequences of deficient growth and development; role of genetics in determining height; role of nutrition in development of the brain; caloric deficiency and obesity in adults; analysis of causes of caloric deficiency; hypovitaminosis in adult populations; and influence of nutritional problems on work capacity and general state of health. (HLW)

25412 Nutritional problems in the labor force and their relation to economic development. Latham, M.C. (Cornell Univ., Ithaca, NY). pp 77-85 of In Nutrition and agricultural development. Significance and potential for the tropics. Scrimshaw, N.S. (ed.). New York; Plenum Press (1976).

From 14. Latin American symposium on nutrition and agricultural and economic development in the tropics; Guatemala City, Guatemala (2 Dec 1974).

See CONF-741264—.

Both work capacity and work output are influenced by the nutrient intake and the nutritional status of those who perform work, be they housewives, persons engaged in subsistence agriculture, or wage earners in the labor force. There is no doubt that the sequelae of childhood malnutrition may also affect the future capacity of individuals for work. Obvious examples have been cited by Dr. Arteaga, and include blindness or poor vision following xerophthalmia; stunting of physical, and perhaps mental, development resulting from protein-calorie malnutrition; skeletal deformities caused by rickets or fluorosis; and several others. But good nutrition for the work force, and for those who one day will enter it, is important not only in terms of productivity. Programs to improve nutrition and health form the cornerstone for human development. It may be that family-planning efforts and population-control programs will fail in most societies that have not attained some fairly good level of health and nutrition for their people. In countries where there is much unemployment and underemployment, labor-intensive rather than capital-intensive development schemes deserve priority. In many of these, agricultural development activities can provide work, can make available more food, and can improve the economy. Economic development must be for the benefit of the majority of people and must be designed to improve their quality of life. It should not be for the benefit of the elite alone, and should not be measured simply in monetary terms. The widening gap between rich and poor individuals, families, and nations has not only economic and political consequences, but also very important nutritional and health implications.

25413 Definition of the nutrition problem in the labor force. Viteri, F.E. (Inst. of Nutrition of Central America and Panama, Guatemala City, Guatemala). pp 87-98 of In Nutrition and agricultural development. Significance and potential for the tropics. Scrimshaw, N.S. (ed.). New York; Plenum Press (1976).

From 14. Latin American symposium on nutrition and agricultural and economic development in the tropics; Guatemala City, Guatemala (2 Dec 1974).

See CONF-741264—.

Some topics discussed are: energy balance of agricultural workers in Guatemala; effect of caloric intake on body weight, adipose tissue, hemoglobin, maximal oxygen consumption, and lean body mass; time/motion studies in supplemented and unsupplemented laborers; iron deficiency anemia in relation to tissue oxygen demands; and effect of anemia on energy-demanding tasks. (HLW)

25414 Nutrition and development: the dynamics of commitment. Field, J.O.; Levinson, F.J. (Massachusetts Inst. of Tech., Cambridge). pp 99-111 of In Nutrition and agricultural development. Significance and potential for the tropics. Scrimshaw, N.S. (ed.). New York; Plenum Press (1976).

From 14. Latin American symposium on nutrition and agricultural and economic development in the tropics; Guatemala City, Guatemala (2 Dec 1974).

See CONF-741264—.

There are grounds for qualified optimism concerning the future role of nutrition in national development programs. While generalization beyond national boundaries is difficult and often misleading, one can state with some confidence that the dynamics outlined in this chapter will represent important elements in policy formation, and that they may well be persuasive in the inclusion of nutrition in national planning. Whatever form these and other dynamics take in individual countries, it is clear that major nutrition allocation decisions will be political decisions. Different governments will react to them in different ways and for a different combination of reasons. The possibility exists that nothing of consequence will happen. Taken alone, each of these dynamics is vulnerable to a token response, especially given the multiplicity of pressures with which governments must cope. In combination, however, and in certain political environments they could bring about significant change. Even with an upgrading of commitment to nutrition, local capabilities will condition what it is possible to accomplish. Ironically perhaps, the nutrition planner's contribution, as he moves beyond advocacy, is likely to lie in the promotion of institutional development and what we have termed effective outreach as well as in the formulation of nutrition programs for their own sake. This would represent a return to a basic proposition in development thinking—often lost sight of in practice—that true development is interactive and reinforcing. Indeed, the capability—impact linkage could be politically attractive in its own right.

25415 Technological and ecological limitations to production of food crops. Waugh, R.K.; Martinez S., E. (Instituto de Ciencia y

Tecnologia Agricolas, Guatemala City, Guatemala). pp 121-138 of In Nutrition and agricultural development. Significance and potential for the tropics. Scrimshaw, N.S. (ed.). New York; Plenum Press (1976).

From 14. Latin American symposium on nutrition and agricultural and economic development in the tropics; Guatemala City, Guatemala (2 Dec 1974).

See CONF-741264—.

The potential for using arable lands in Latin America for food production is discussed. Ratios of high to low crop yields are given for rice, wheat, and corn. Technological problems are discussed with regard to lack of well-adapted, high-yielding varieties; seed production from improved varieties; lack of varieties adaptable to associated or mixed cropping systems; insects; plant diseases; fertilization; salinity; rainfall; weeds; soil preparation; slope of the land, and other factors. Advances in technology and relation of governments to agricultural technology are also discussed. (HLW)

25416 Technological and ecological problems limiting production of foods of animal origin. Solana M., P.; Gonzalez P., E.; Garza T., R. (Instituto Nacional de Investigaciones Pecuarias, Palo Alto, MX). pp 139-151 of In Nutrition and agricultural development. Significance and potential for the tropics. Scrimshaw, N.S. (ed.). New York; Plenum Press (1976).

From 14. Latin American symposium on nutrition and agricultural and economic development in the tropics; Guatemala City, Guatemala (2 Dec 1974).

See CONF-741264—.

The ecology of Mexico is discussed with regard to effects of climate and soil types on cattle raising and production of feed for animals. Cattle production on pastures is discussed with regard to nutrition, reproductive efficiency, genetics, management, and animal health. (HLW)

25417 Aquatic protein in Latin America. Borgstrom, G. (Michigan State Univ., East Lansing). pp 153-156 of In Nutrition and agricultural development. Significance and potential for the tropics. Scrimshaw, N.S. (ed.). New York; Plenum Press (1976).

From 14. Latin American symposium on nutrition and agricultural and economic development in the tropics; Guatemala City, Guatemala (2 Dec 1974).

See CONF-741264—.

Some topics discussed are as follows: use of fish protein to feed livestock; waste accompanying shrimping in Latin America; excessive cost of freezing as a method of preservation; and preservation by means of chilling, drying, salting, smoking, canning, and manufacture of fish meal. (HLW)

25418 Technological and ecological problems limiting the production of freshwater and marine fishes in Latin America. Schafer, H.J. (Instituto Tecnologico y de Estudios Superiores de Monterrey, Mexico). pp 157-161 of In Nutrition and agricultural development. Significance and potential for the tropics. Scrimshaw, N.S. (ed.). New York; Plenum Press (1976).

From 14. Latin American symposium on nutrition and agricultural and economic development in the tropics; Guatemala City, Guatemala (2 Dec 1974).

See CONF-741264—.

Some topics discussed are as follows: effect of thermocline on productivity of tropical waters; production of phytoplankton and zooplankton; variety of species supported by tropical waters; aquaculture in Latin America; studies on environmental conditions in coastal lagoons and estuaries; and research funds for studies on Latin American fisheries resources. (HLW)

25419 Food and cash crop competition. West, Q.M. (Dept. of Agriculture, Washington, DC). pp 163-169 of In Nutrition and agricultural development. Significance and potential for the tropics. Scrimshaw, N.S. (ed.). New York; Plenum Press (1976).

From 14. Latin American symposium on nutrition and agricultural and economic development in the tropics; Guatemala City, Guatemala (2 Dec 1974).

See CONF-741264—.

Some topics discussed are as follows: need for increase in food production in Latin America; responsibility of agriculture to earn foreign exchange to pay for imports; increase in wheat yields in Mexico since 1950; increase in total food production in Latin America; lack of adequate diet in some countries despite agricultural improvements; need for expanding food and industrial crops; problems of population growth and urbanization; and relation of economic welfare to nonagricultural factors. (HLW)

25420 Energy and food. Slesser, M. (Strathclyde Univ., Glasgow). pp 171-178 of In Nutrition and agricultural development. Significance and potential for the tropics. Scrimshaw, N.S. (ed.). New York; Plenum Press (1976).

From 14. Latin American symposium on nutrition and agricultural and economic development in the tropics; Guatemala City, Guatemala (2 Dec 1974).

See CONF-741264—.

Some topics discussed are: energy consumption in food production in developed countries; energy requirements for food production and population; systems view of food production; and agricultural policy for developing countries. (HLW)

25421 Toxicity of organic and inorganic arsenicals to an insect herbivore. Watson, A.P.; Van Hook, R.I.; Reichle, D.E. (Oak Ridge National Lab., TN). *Environ. Sci. Technol.;* **10**: 356-359(Apr 1976).

Four arsenicals including organic and inorganic forms of both the trivalent and pentavalent states were tested for their potential environmental effect on a nontarget animal species. Cacodylic acid, cacodylic acid plus sodium cacodylate, arsenic trioxide, and arsenic pentoxide were evaluated in terms of formulation, exposure time, and tissue arsenic concentrations on the survival of an exposed population of meadow katydids. Tissue concentrations of elemental arsenic were higher for organic forms than for inorganic forms at similar exposure dosages. Life expectancies were reduced to less than 10 percent of unexposed populations by levels above 5 μg As/g dry weight in dosing formulations. While As concentrations in katydid tissues did not exceed those in the dosing formulations, they did exceed tissue concentrations found in unexposed populations by as much as three orders of magnitude. These results illustrate the impact of herbicidal arsenic formulations on a nontarget animal species.

BIOMEDICAL SCIENCES, APPLIED STUDIES

RADIATION EFFECTS ON BIOCHEMICALS

IN VITRO

25422 Mechanisms involved in the chemical inhibition of the Eosin-sensitized photooxidation of trypsin. Rizzuto, F.; Spikes, J.D. (Univ. of Utah, Salt Lake City). *Radiat. Environ. Biophys.;* **12**: 217-232(1975).

A large series of compounds was screened for ability to protect trypsin from eosin-sensitized photodynamic inactivation. Eosin-sensitized photooxidation reactions of this type typically proceed via the triplet state of the dye and often involve singlet state oxygen as the oxidizing entity. In order to determine the mechanisms by which trypsin is protected from photoinactivation, a number of good protective agents (inhibitors) and some non-protective agents were selected for more detailed flash photolysis studies. Good inhibitors such as p-phenylenediamine, n-propyl gallate, serotonin creatinine sulfate and p-toluenediamine competed efficiently with oxygen and with trypsin for reaction with the triplet state of eosin. The inhibitors were shown to quench triplet eosin to the ground state and/or reduce triplet eosin to form the semireduced eosin radical and an oxidized form of the inhibitor. In the latter case, oxidized inhibitor could react by a reverse electron transfer reaction with the semireduced eosin radical to regenerate ground state eosin and the inhibitor. The good inhibitors also competed effectively with trypsin for oxidation by semioxidized eosin, thus giving another possible protective mechanism. Non-inhibitors such as halogen ions and the paramagnetic ions Co^{++}, Cu^{++} and Mn^{++} reacted only slowly with triplet and with semioxidized eosin. The primary pathway for the eosin-sensitized photooxidation of trypsin at pH 8.0 involved singlet oxygen, although semioxidized eosin may also participate.

25423 Oxygen-independent inactivation of Haemophilus influenzae transforming DNA by monochromatic radiation: action spectrum, effect of histidine and repair. Cabrera-Juarez, E.; Setlow, J.K.; Swenson, P.A.; Peak, M.J. (Escuela Nacional de Ciencias Biologica, Mexico City). *Photochem. Photobiol.;* **23**: 309-313(1976).

The action spectrum for the oxygen-independent inactivation of native transforming DNA from Haemophilus influenzae with near-uv radiation revealed a shoulder beginning at 334 and extending to 460 nm. The presence of 0.2 M histidine during irradiation produced a small increase in inactivation at 254, 290 and 313 nm, a large increase at 334 nm and a decrease in inactivation at 365, 405, and 460 nm. Photoreactivation did not reverse the DNA damage produced at pH 7.0 at 334, 365, 405 and 460 nm, but did reactivate the DNA after irradiation at 254, 290 and 313 nm. The inactivation of DNA irradiated at 254, 290 and 313 nm was considerably greater when the transforming ability was assayed in an excision-defective mutant compared with the wild type, although DNA irradiated at 334, 365, 405 and 460 nm showed smaller differences. These results suggest that the oxygen-independent inactivation of H. influenzae DNA at pH 7 by irradiation at 334, 365, 405 and 460 nm is caused by lesions other than pyrimidine dimers.

25424 Kinetic formaldehyde analysis of DNA ultraviolet irradiated in the presence of silver ions. Rahn, R.O.; Stafford, R.S. (Oak Ridge National Lab., TN). *Photochem. Photobiol.;* **24**: 243-248(1976).

DNA from Escherichia coli was irradiated at 254 nm in the presence of silver in order to preferentially enhance the rate of formation of pyrimidine-dimer damage over nondimer damage. The irradiated DNA was treated with formaldehyde in order to measure the unwinding velocity of the defects associated with the pyrimidine dimers. This velocity was found to be 0.18 base pairs/min per pyrimidine dimer, which is nearly 8 times less than that found for a double-strand break (1.37 base pairs/min) obtained by use of sheared DNA whose size was determined by electron microscopy. The rate of reaction of the DNA with formaldehyde varied linearly with the pyrimidine dimer concentration and showed no inflection due to clustering. Treatment of irradiated DNA with UV endonuclease enhanced the formaldehyde reaction by approximately 7-fold, consistent with the conversion of a dimer into the faster-reacting defect associated with a single-strand break. These results indicate that the distribution of dimers in DNA is random and not clustered, and that previous interpretations of clustering were based on the false assumption that dimer and chain break defects unwind with similar velocities when treated with formaldehyde.

25425 (ERDA-tr—210, pp 50-55) **Contribution of the sorption of the protection on the active center in the protection of an enzyme from gamma irradiation.** Kravetskaya, T.P.; Kurtyakov, V.M.; Sverdlov, A.G. (Leningrad Inst. of Nuclear Physics). 1976. Translated from Radiobiologiya; 16: No. 2, 200-204(1976).

In Radiobiology.

It was shown that 5-methoxytryptamine (mexamine) is a competitive inhibitor of trypsin. Therefore, it proved possible to compare the protection under conditions when 90 percent of the enzyme molecules are present in a free form, and 90 percent of the enzyme molecules carry a molecule of the protector on the active site. It was established that the sorption of mexamine on the active site of trypsin increases the protection four-fold. A quantitative comparison of the values of the protection of the enzyme by a tissue extract of "cellular" concentration and by mexamine in the maximum "organismic" concentration shows that the interception of radicals is not the principal mechanism of the action of the protector in the cell, even when the sorption of mexamine on the biopolymers is taken into consideration.

25426 (ERDA-tr—227, pp 11-17) **Role of functional template damage in the process of DNA replication and repair in the rat thymus, in the presence of radiation pathology.** Belovskaya, L.N.; Filippovoch, I.V.; Romantsev, E.F. 1976. Translated from Radiobiologiya; 16: No. 4, 491-496(1976).

In Radiobiology.

Evaluation was made of the effects of in vitro and in vivo irradiation of DNA template on effectiveness of replicative and repair synthesis. It was shown that the intensity of replicative DNA synthesis is virtually unchanged, while repair synthesis becomes more intensive soon after irradiation (5 min), then reverts to normal. The distinct radioprotective effect of specific inhibitors of replication, nalidixic acid and cytarabine, was demonstrated in experiments on thymocyte cultures. This is apparently attributable to more complete occurrence of repair prior to the time of intensification of primary damage to the template while replication was blocked by the specific inhibitors.

25427 (ERDA-tr—227, pp 31-36) **Radiochemical modification of dermal collagen in the presence of water.** Shifrim, I.G. (Central Scientific Research Inst. of the Tanning and Shoe Industry, Moscow). 1976. Translated from Radiobiologiya; 16: No. 4, 508-512(1976).

In Radiobiology.

When collagen is irradiated in the presence of water, there is a radiochemical modification of the protein, manifested by elevation of welding temperature, greater resistance to enzymes and associated with formation of additional crosslinkages between protein chains. Interaction between aldehyde groups of the protein plays the decisive part in formation of crosslinkage. The process of radiochemical modification of collagen can be used to improve some indices of leather.

25428 **Repair of double-strand breaks in DNA: a model involving recombination.** Resnick, M.A. (Univ. of Rochester, NY). *J. Theor. Biol.;* **59**: 97-106(1976).

A model is described for the repair of induced double-strand breaks in DNA which involves a proposed heteroduplex intermediate and normally occurring repair enzymes. The model predicts that this repair can lead to non-reciprocal and/or reciprocal recombination. The evidence which has been evaluated from other studies indicates a clear correspondence between the production of double-strand breaks and the occurrence of intragenic recombinants. In addition, the model describes how enzymatically-induced double-strand breaks could initiate recombination without concomitant loss of chromosomal segments.

25429 **Rate of DNA chain elongation in ultraviolet light-irradiated mammalian cells as estimated by a bromodeoxyuridine photolysis method.** Povirk, L.F.; Painter, R.B. (Univ. of California, San Francisco). *Biophys. J.;* **16**: 883-889(Aug 1976).

Using a new method, we show that, when the DNA chain elongation rate is measured for short time periods, ultraviolet light does not decrease this rate. The method is based on the photolysis of bromouracil-containing DNA by 313 nm light and alkaline sucrose gradients.

IN MICROORGANISMS

25430 **Degradation of DNA in Haemophilus influenzae cells after x-ray irradiation. II. Comparison with theoretical models.** Randolph, M.L. (Oak Ridge National Lab., TN). *J. Theor. Biol.;* **60**: 59-91(1976).

Models of the kinetics of degradation of DNA in bacterial cells following exposure to x-rays are developed and tested using data obtained with various strains of Haemophilus influenzae cells. Different mathematical models allow for different initial distributions of DNA lengths, depending on cell phase and assumed replication model, and for unilateral or bilateral degradation from initiation points, which are taken as single-strand breaks. In order to explain the observed magnitude and time course of degradation an interruption-of-degradation probability, which may be interpreted as the result of an x-ray inducible inhibitor, is introduced. Interruption of degradation is interpreted as an early and essential, but not necessarily sufficient, step for repair of DNA. Empirical best fits to the kinetic data were obtained by iterative calculation methods based on varying the rate parameters. Depending somewhat on the strain and cell phase, the data seem best described by assuming bilateral degradation, perhaps at different rates, whose total for log phase wild-type cells is roughly 5×10^3 nucleotides/min and an interruption rate of about 0.03/min. For stationary phase the total degradation rate is greater and the probability of degradation unchanged. Differences in the kinetics between strains are discussed briefly.

25431 **ATP dependence of the incision and resynthesis steps of excision repair.** Masker, W.E. (Oak Ridge National Lab., TN). *Biochim. Biophys. Acta;* **442**: 162-173(1976).

Escherichia coli made permeable by treatment with toluene can perform a mode of DNA synthesis that is stimulated by ultraviolet radiation and closely resembles the resynthesis step of excision repair. If ultraviolet-irradiated toluene-treated cells are incubated in an assay mixture with ATP but without the four deoxyribonucleoside triphosphates (dNTPs) or NAD, accumulations of single-strand breaks in the DNA are detected by alkaline sucrose gradient analysis. A second incubation with the dNTPs and NAD but without ATP produces nonconservative DNA synthesis in strains with normal levels of DNA polymerase I. However, in polA strains, ATP must be present during the second incubation in order to produce measurable amounts of ultraviolet-stimulated DNA synthesis. These results suggest that in strains deficient in DNA polymerase I there may be two ATP-dependent steps in this repair pathway, one required for incision and one associated with resynthesis.

25432 **Repair of x-ray-induced single strand breaks in toluenized Escherichia coli cells.** Waldstein, E.A. (Tel Aviv Univ. (Israel). Dept. of Botany); Setlow, R.B. (Brookhaven National Lab., Upton, N.Y. (USA)). *Biochim. Biophys. Acta;* **442**: No. 2, 154-161(18 Aug 1976).

Sedimentation in alkali was used to estimate the repair of X-ray-induced single strand breaks in the DNA of irradiated toluenized Escherichia coli cells in this study. Extensive repair requires no exogenous cofactors except ATP, although other individual NTPs (except U) or dNTPs can substitute for ATP. There is no repair in polA or resA cells and since nicotinamide mononucleotide (NMN) inhibits repair in wild type cells the results are interpreted as indicating that both ligase and polymerase I are needed for repair but that the amount of any gap filling is small and extensive repair replication is not necessary.

IN ANIMALS

REFER ALSO TO CITATION(S) 25426

25433 (ERDA-tr—210, pp 23-28) **Influence of ionizing radiation on the activity of components of the system DNAsI: natural inhibitor of NDase I in the blood serum of white rats.** Ivanova, A.B.; Kerova, N.I.; Pukhova, G.G.; Baraboi, V.A. (Kiev Roentgenoradiological and Oncological Inst.). 1976. Translated from Radiobiologiya; 16: No. 2, 179-183(1976).

In Radiobiology.

The inhibitory effect of blood serum with respect to pancreatic DNase is due to the presence of a natural inhibitor of DNAs I of protein nature. Depending on the dose (450 to 750 R), the activity of the serum inhibitor of DNAs I after brief activation is normalized in a period from 15 min to one day (450 R) or decreases sharply on the seventh day (750 R). In the case of irradiation at a dose of 750 R, the activity of free serum DNase I increases throughout the entire experiment; the activity of bound DNase I gradually decreases and is

not detected on the seventh day. An influence at a dose of 450 R does not significantly change the activity of free DNase I. Evidently under the influence of large doses of x-rays, a disruption of the complex formation of the inhibitor with serum DNase I is observed.

25434 (ERDA-tr—227, pp 1-5) **Effects of transcription and translation inhibitors on repair and degradation of irradiated thymocyte DNA.** Ivannik, B.P.; Golubeva, R.V.; Proskuryakov, S.Ya.; Ryabchenko, N.I. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). 1976. Translated from Radiobiologiya; 16: No. 4, 483-486(1976).

In Radiobiology.

A suspension of rat thymocytes was exposed to 3 kR radiation at 0°C. Incubation of irradiated thymocytes at 37°C for 1 hour leads to repair of single-stranded breaks of DNA; however, by the 3d postradiation hour, the molecular weight of single-stranded DNA decreases. Puromycin (20 μg/ml) and cycloheximide (200 μg/ml) do not prevent DNA repair, but they do inhibit postradiation degradation of DNA. Actinomycin D (1 μg/ml) totally inhibits repair of single-stranded breaks, but does not prevent postradiation degradation of DNA.

25435 (ERDA-tr—227, pp 6-10) **Investigation of the possibility of repair of mitochondrial DNA in ascites hepatoma cells of rats exposed to x irradiation.** Khanson, K.P.; Kalashnikov, N.V.; Komar, V.E. (Central Scientific Research Inst. of Roentgenology and Radiology, Leningrad). 1976. Translated from Radiobiologiya; 16: No. 4, 487-490(1976).

In Radiobiology.

Ultracentrifugation of lysates of mitochondrial cells of Zajdela ascites hepatoma, the DNA of which was submitted to prolonged ^{3}H-thymidine labeling, demonstrated three discrete peaks of radioactivity (35-38S, 26-27S and 21-22S), corresponding to supercoiled, open circular and linear molecules of mitochondrial DNA. Immediately after whole-body iradiation of rats in a dosage of 2000 rad, shifting of radioactive material is observed, from the region of supercoiled and open molecules to the zone of linear structures with sedimentation constants of 21-22S and 8-10S. Postradiation incubation of cells for 2 hours results in appreciable restoration of the initial sedimentation profile of mitochondrial DNA. The mechanisms of the demonstrated effect are discussed.

25436 (ERDA-tr—227, pp 18-23) **Effects of ATP on DNA damage induced by prolonged irradiation.** Komolova, G.S.; Tikhomirova, M.V.; Makeeva, V.F.; Belikova, E.V.; Guseinov, F.T.; Rogozkin, V.D.; Egorov, I.A. 1976. Translated from Radiobiologiya; 16: No. 4, 497-501(1976).

In Radiobiology.

Therapeutic and protective administration of ATP to dogs exposed to prolonged irradiation in the minimal absolutely lethal dosage, 800 R (1 R/min) diminishes degradation changes in the DNA of the spleen, lowers postradiation activation of acid DNAase, and attenuates the severity of the early radiation induced hematological reaction.

RADIATION EFFECTS ON CELLS

EXTERNAL SOURCE

REFER ALSO TO CITATION(S) 25246, 25446

25437 (CONF-761212—1) **Mechanisms in endogenous leukemia virus induction by radiation and chemicals.** Tennant, R.W.; Rascati, R.J.; Lavelle, G.C. (Oak Ridge National Lab., Tenn. (USA)). 1976. Contract W-7405-ENG-26;SUB-3322. 19p. Dep. NTIS $3.50.

From Symposium on radiation-induced leukemogenesis and related viruses; Bordeaux, France (7 Dec 1976).

A model of endogenous leukemia virus induction in AKR strain mouse cells based on two distinct types of alterations in cellular or proviral DNA is presented. The first type are non-repairable alterations, such as those caused by the incorporation of halogenated pyrimidines; the second type are repairable lesions, such as those caused by irradiation or certain other chemicals. The production of non-repairable lesions leads to the formation of a stable, proviral state which is dependent upon cell division for complete virus expression. A stable provirus intermediate state is not demonstrable in cells induced by treatments which cause repairable lesions, since replication of damaged or altered DNA must occur before the lesions are removed by repair synthesis. Experimental support for this model is presented.

25438 (ERDA-tr—210, pp 79-87) **Change in the survival of mammalian cells under the influence of an inhibitor of DNA synthesis under conditions of fractionated and single irradiation.** Gotlib, V.Ya.; Pelevina, I.I. (Academy of Sciences, Moscow). 1976. Translated from Radiobiologiya; 16: No. 2, 223-229(1976).

In Radiobiology.

The ability of cells of the LL line in the stage of active reproduction to repair sublethal (SLD) and potentially lethal damages (PLD) under the influence of an inhibitor of DNA synthesis—hydroxyurea (HU) was investigated. It was shown that HU (10^{-4} M) increases the effect of fractionation and the degree of repair of SLD when the preparation is introduced into the culture 1, 3, and 6 hrs after irradiation. In the case of a prolonged influence of HU before irradiation (18 to 20 hrs), the effect of fractionation is increased, which may be associated with the action of toxic products, formed as a result of metabolism from HU. HU in a higher concentration (10^{-3} M) decreases the repair of SLD.

25439 **DNA repair in late-passage human cells.** Hart, R.W.; Setlow, R.B. (Oak Ridge National Lab., TN). *Mech. Ageing Dev.;* **5**: 67-77(1976).

Monolayer cultures of WI-38 cells from passages 18 to 60 were exposed to ultraviolet radiation, or to N-acetoxy-AAF, or to gamma-rays. The cultures were incubated in ^{3}H-dThd, and unscheduled DNA synthesis—a measure of DNA repair—was measured radioautographically. Late passage cultures showed less repair, and many cells showed none. Double-label radioautographs indicated that there is an excellent correlation between cells that do scheduled synthesis and cells that do unscheduled synthesis. We interpret our results as indicating that failure of repair is not a causal event in the failure of late passage cells to divide, but that as cells age the ability to do the many coordinated steps in repair declines.

25440 **Effects of ionizing radiation on RNA metabolism in cultured mammalian cells. III. Specific reduction in mRNA synthesis during resumed division and plateau phases following exposure to 800 rads of x irradiation.** Enger, M.D.; Campbell, E.W.; Walters, R.A.; Crissman, H.A.; Steinkamp, J.A. (Los Alamos Scientific Lab., N.Mex. (USA)). *Biochim. Biophys. Acta;* **442**: No. 3, 297-308(6 Sep 1976).

The cell growth respone of cultured Chinese hamster ovary cells, line CHO, to 800 rads of X irradiation involves a period of division delay, followed by a period of resumed division which terminates in a plateau phase. Over 95% of the cells die eventually. No direct effects on RNA or protein metabolism are evident during the delay period. During the resumed division and beginning of plateau phases, however, a specific and relatively constant reduction in mRNA synthesis relative to messenger-like RNA and heterogeneous nuclear RNA synthesis is evidenced. The ratio of mRNA to messenger-like RNA synthesis ranges from 0.8 to 0.65 during these phases. The effect is not due to altered cell-cycle distribution, and evidence is presented to indicate that it is probably not a compensatory response to the unbalanced growth that occurs during the division delay period.

RADIATION EFFECTS ON MICROORGANISMS

BASIC STUDIES

REFER ALSO TO CITATION(S) 25431, 25432, 25446

25441 (ERDA-tr—210, pp 56-60) **Characteristics of the energy links in the generation of the membrane potential in Streptococcus faecalis after gamma irradiation.** Fomenko, B.S. (Inst. of Biological Physics, Pushchino, USSR). 1976. Translated from Radiobiologiya; 16: No. 2, 205-208(1976).

In Radiobiology.

On irradiated cells of Str. faecalis (20 to 100 krad), an increase in their glycolytic and ATPase activity was shown, while the level of ATP was unchanged under the action of radiation. It is concluded that the previously described decrease in the membrane potential after the irradiation of Str. faecalis is not associated with a disruption of the energy system of generation of the potential.

25442 **Irradiation of bacterial spores in water: three classes of oxygen-dependent damage.** Ewing, D.; Powers, E.L. (Univ. of Texas, Austin). *Science;* **194**: No. 4269, 1049-1051(3 Dec 1976).

Studies of irradiated bacterial spores in aqueous suspension indicate that the sensitization of spores by oxygen can depend on three chemical processes. One of these processes involves reactions of hydroxyl radicals; the other two apparently do not.

RADIATION EFFECTS ON ANIMALS

REFER ALSO TO CITATION(S) 25446

MAN

25443 (CONF-761153—1) **Image quality in mammography.** Haus, A.G.; Doi, K.; Metz, C.E. Bernstein, J. (Franklin McLean Memorial Research Inst., Chicago, Ill. (USA)). 1976. Contract EY-76-C-02-0069;USPHS-GM-18940. 29p. Dep. NTIS $4.00.

From 62. annual meeting of radiologic advances in breast cancer; Chicago, Illinois, United States of America (USA) (15 Nov 1976).

In mammography, image quality is a function of the shape, size, and x-ray absorption properties of the anatomic part to be radiographed and of the lesion to be detected; it also depends on geometric unsharpness, and the resolution, characteristic curve and noise properties of the recording system. X-ray energy spectra, modulation transfer functions, Wiener spectra, characteristic and gradient curves, and radiographs of a breast phantom and of a resected breast specimen containing microcalcifications are used in a review of some current considerations of the factors, and the complex relationship among factors, that affect image quality in mammography. Image quality and patient radiation exposure in mammography are interrelated. An approach to the problem of evaluating the trade-off between diagnostic certainty and the cost or risk of performing a breast imaging procedure is discussed.

25444 (CONF-761153—3) **Determination of x-ray spectra incident on and transmitted through whole excised breast for improved mammographic exposing technique.** Haus, A.G.; Metz, C.E.; Doi, K.; Bernstein, J. (Franklin McLean Memorial Research Inst., Chicago, Ill. (USA)). 1976. Contract EY-76-C-02-0069;USPHS-GM-18940. 13p. Dep. NTIS $3.50.

From 62. annual meeting of radiologic advances in breast cancer; Chicago, Illinois, United States of America (USA) (15 Nov 1976).

Measurements were made of x-ray spectra incident on and transmitted through whole excised fresh breast tissue. The spectra and corresponding radiographs show that hardening of the x-ray beam from a molybdenum anode x-ray tube by a 0.5 mm Al filter instead of the conventional 0.03 mm Mo filter allows shorter exposure times and reduces patient radiation exposure. With the Al filter, acceptable image contrast is preserved in mammography of thick or dense breasts.

VERTEBRATES

REFER ALSO TO CITATION(S) 25426, 25433, 25434, 25435, 25436

25445 (CONF-760744—2) **Genetic effects of radiation.** Selby, P.B. (Oak Ridge National Lab., Tenn. (USA)). 1976. Contract W-7405-ENG-26. 13p. Dep. NTIS $3.50.

From Conference on energy sources of the future; Oak Ridge, Tennessee, United States of America (USA) (5 Jul 1976).

Data are reviewed from studies on the genetic effects of x radiation in mice and the extrapolation of the findings for estimating genetic hazards in man is discussed. Data are included on the frequency of mutation induction following acute or chronic irradiation of male or female mice at various doses and dose rates.

25446 (ERDA-tr—210) **Radiobiology.** Translation of *Radiobiologiya;* **16**: No. 2, 163-320(1976). 212p. Dep. NTIS $7.75.

Separate abstracts were prepared for the 37 papers presented in this issue of the journal. (ERB)

25447 (ERDA-tr—210, pp 11-16) **DNA repair, change in the DNA polymerase and DNA ligase activities in the regenerating liver of gamma-irradiated rats.** Zakrzhevskaya, D.T.; Vtyurin, N.N.; Gaziev, A.I. (Inst. of Biological Physics, Pushchino, USSR). 1976. Translated from Radiobiologiya; 16: No. 2, 171-174(1976).

In Radiobiology.

It was shown that in the regenerating liver of γ-irradiated rats, in a period of 3 hrs after irradiation, an incomplete repair of single-stranded breaks in DNA is observed. By 5 to 10 hrs after irradiation, the repair of breaks in DNA is not recorded, and a decrease in the activity of DNA polymerase and DNA ligase is observed. The change in the enzymes in the regenerating liver is correlated with the effectiveness of DNA repair and is not associated with the appearance of an inhibiting factor.

25448 (ERDA-tr—210, pp 17-22) **Investigation of the process of transcription in thymus cells of rats subjected to x irradiation. Communication 2. Influence of exogenous deoxyribonucleic acids on the hydridization of nuclear RNA with repetitive and unique DNA sequences.** Zhivotovskii, B.D.; Khanson, K.P. (Central Roentgeno-Radiological Scientific Research Inst., Leningrad). 1976. Translated from Radiobiologiya; 16: No. 2, 175-178(1976).

In Radiobiology.

The hybridization of heterogeneous nuclear RNA (hnRNA) of rat thymus cells, stimulated by PHA, under conditions of the reaction with a large excess of DNA, was studied. It was shown that x-irradiation of the animals at a dose of 40 rad suppresses the hydrolyzability of the hnRNA of the thymocytes in culture. The introduction of 2.5 μg/ml exogenous nuclear and mitochondrial DNA into the medium does not lead to normalization of the process studied.

25449 (ERDA-tr—210, pp 29-35) **Influence of DNA on the incorporation of ^{3}H-thymidine into bone marrow cells of irradiated rats.** Rogacheva, S.A. 1976. Translated from Radiobiologiya; 16: No. 2, 184-188(1976).

In Radiobiology.

It was established by the method of autoradiography that in rats irradiated at a dose of 655 R ($LD_{50/30}$), the index of labeling of myelokaryocytes with ^{3}H-thymidine was lowered, whereas the intensity of labeling increased substantially. The administration of homologous DNA to the irradiated rats normalized or increased the index of labeling, as well as the mitotic index of the myelokaryocytes, in comparison with that of intact animals. In DNA-treated rats, over a period of 30 days, a high intensity of labeling of the myelokaryocytes was stably maintained, in contrast to the control.

25450 (ERDA-tr—210, pp 36-42) **Peculiarities of postradiation restoration of the DNP and PDN content in various tissues of rats after acute irradiation and administration of high-polymer DNA.** Rysina, T.N. 1976. Translated from Radiobiologiya; 16: No. 2, 189-194(1976).

In Radiobiology.

In the tissues of rats irradiated at a dose of 710 R, over a period of 15 days after the influence, the amounts of DNP and PDN and the rate of incorporation of ^{3}H-thymidine into these fractions were investigated. The period of the beginning and the rate of restoration of the DNP content in the tissues studied varied; the dynamics of the incorporation of the precursor also differed. The possible role of PDN in the course of postradiation tissue regeneration is discussed. The administration of high-polymer DNA to irradiated animals did not accelerate recovery processes in the systems studied.

25451 (ERDA-tr—210, pp 43-49) **Change in the content of deoxyribonucleoprotein in the rat spleen and thymus in the case of chronic gamma irradiation.** Misurova, E.; Frasličkа, M.; Mackova, N. (Inst. of General Biology, Kosice, Czech.). 1976. Translated from Radiobiologiya; 16: No. 2, 195-199(1976).

In Radiobiology.

Chronic irradiation of rats at dose rates up to 10 R/day, in 60 days of irradiation, produced only a temporary decrease in the content of deoxyribonucleoproteins (DNP) in the spleen and thymus; in the case of irradiation at a dose rate of 25 to 100 R/day, the decrease in the DNP content over the investigated period proved irreversible. The observed data were compared with the changes in the DNP concentration and the weight of the organs.

25452 (ERDA-tr—210, pp 61-65) **Chemiluminescence of liver mitochondria of rats irradiated with fast neutrons.** Druzhina, N.A.; Chebotarev, E.E.; Ryabova, E.Z.; Serkiz, Ya.I. (Inst. of Problems of Oncology, Kiev). 1976. Translated from Radiobiologiya; 16: No. 2, 209-212(1976).

In Radiobiology.

The chemiluminescence of the liver mitochondria of rats irradiated with fast neutrons was studied in the work. Luminescence was induced with ferrous ions. The kinetics of the development of luminescence of the mitochondria during the early periods after irradiation (1 to 6 days) was demonstrated. As the development of radiation sickness progressed, an exponential increase in the intensity of the rapid flash was noted. Dilution of the mitochondria to a definite level leads to a decrease in the "radiation effect."

25453 (ERDA-tr—210, pp 66-72) **Restoration of the number of colony forming units in the bone marrow and spleen of DNA-treated irradiated mice.** Luzanov, V.M. 1976. Translated from Radiobiologiya; 16: No. 2, 213-217(1976).

In Radiobiology.

It was shown by methods of endogenous and exogenous colonies that the introduction of isologous DNA promoted a more intensive restoration of the number of colony-forming units (CFU) in irradiated mice. Probably such an action of exogenous DNA occurs on account of an intensification of the proliferative activity of the CFU and an increase in their migration from the bone marrow into the spleen. The optimum doses of DNA were 0.3 to 0.7 mg per mouse.

25454 (ERDA-tr—210, pp 73-78) **Influence of certain biologically active preparations on a population of cells of the stem fraction of hemopoiesis and on the survival of irradiated mice. Communication 3. Interferon.** Semina, O.V.; Neifakh, Yu.A.; Soboleva, E.L.; Konoplyannikov, A.G.; Poverennyi, A.M. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). 1976. Translated from Radiobiologiya; 16: No. 2, 218-222(1976).

In Radiobiology.

It has been established that when animals are administered partially purified exogenous interferon two days before irradiation, the yield of endogenous spleen colonies is increased, and the survival of the irradiated mice is increased. Incubation of a suspension of bone marrow cells of mice with interferon leads to a decrease in the yield of exogenous spleen colonies. Evidently such an action of interferon is associated with its influence on the cell cycle of the CFU. It is suggested that a great role in the mechanism of the action

of poly I:C on a cell population of the stem fraction of hemopoiesis is played by the level of endogenous interferon.

25455 (ERDA-tr—210, pp 88-93) **Antioxidative activity of lipids and radiosensitivity. Communication 3. Influence of a directed change in the antioxidative activity of lipids when synthetic antioxidants are introduced on the radioresistance of mice.** Shishkina, L.N.; Pal'mina, N.P.; Burlakova, E.B. (Inst. of Chemical Physics, Moscow). 1976. Translated from Radiobiologiya; 16: No. 2, 230-233(1976).

In Radiobiology.

Using a methyl oleate oxidative model, the change in the level of antioxidative activity (AOA) of the lipids of the spleen of mice of the BALB line after they received 4-hydroxy-3,5-ditert-butyl-α-methylbenzylamine hydrochloride in an amount of 25 mg/kg and 6-methyl-2-ethyl-3-hydroxypyridine in an amount of 200 mg/kg was studied. The average lifetime and survival of the mice irradiated at a dose of 650 R at various times after the introduction of the indicated preparations was investigated. It was shown that the influence of the AOA of the spleen lipids of mice leads to a directed change in the radioresistance of the animals (coefficient of correlation $r = 0.89 +- 0.05$).

25456 (ERDA-tr—210, pp 94-99) **Kinetic peculiarities of the restoration of a population of hemopoietic cells in a two-component model.** Monichev, A.Ya.; Gruzdev, G.P. (Gorkii Physicotechnical Research Inst., USSR). 1976. Translated from Radiobiologiya; 16: No. 2, 234-238(1976).

In Radiobiology.

The kinetic manifestations of the interaction of hemopoietic stem cells with cells of the dividing-maturing pool in processes of postradiation repair were investigated by the method of mathematical model study. The proposed model was used for the consideration of the phenomenon of abortive rise and overshoot.

25457 (ERDA-tr—210, pp 100-105) **Certain biochemical effects of partial irradiation of the organism under the combined action of radiation.** Matyushichev, V.B.; Taratukhin, V.R.; Yuzhakova, G.A. 1976. Translated from Radiobiologiya; 16: No. 2, 239-242(1976).

In Radiobiology.

The influence of x-irradiation at a dose of 50 R (total, irradiation of the anterior third or posterior two-thirds of the body), as well as external β irradiation with ^{85}Kr at a dose of 3.05 krad, used separately and in combinations, on the ATPase and creatin kinase activity of aqueous extracts from the brain, liver, and spleen tissue of rats 5, 12, 19, and 26 days after irradiation was investigated. It was shown that under the conditions selected, the partial radiation loads are entirely comparable in their biochemical effectiveness with the effect of whole-body irradiation. Combined irradiation as a whole was less effective than separate irradiation.

25458 (ERDA-tr—210, pp 106-113) **Role of the liver in the pathogenesis of acute radiation sickness.** Yaralova, P.V.; Pinchuk, L.B. (Kiev Scientific Research Inst. of Hematology and Blood Transfusion). 1976. Translated from Radiobiologiya; 16: No. 2, 243-248(1976).

In Radiobiology.

The results of an investigation of certain aspects of the functional state of the liver during acute radiation sickness were analyzed. It was shown that when animals are irradiated with x-rays in the absolutely lethal dose, the damage to the liver is one of the syndromes that necessarily develops. It was shown that transfusions of a 10 percent solution of serum albumin intensify the compensatory potentialities of the liver tissue. The use of agents directed toward the correction of the functional state of the liver at early periods after irradiation is essential in the rational scheme of therapy of acute radiation sickness.

25459 (ERDA-tr—210, pp 114-119) **Peculiarities of the toxicity and radioprotective activity of aminopropyl aminoethyl thiophosphate.** Terekhov, A.V.; Besedina, L.N.; Zherebchenko, P.G.; Znamenskii, V.V.; Suslikov, V.I.; Titov, B.A. 1976. Translated from Radiobiologiya; 16: No. 2, 249-252(1976).

In Radiobiology.

The toxicity and radioprotective activity of aminopropyl aminoethyl thiophosphate (APAETP) were studied in the work in comparison with cystaphos. It was shown that APAETP somewhat surpasses cystaphos in magnitude of the radioprotective effect, but in duration of action in the case of intraperitoneal injection, it is inferior to the latter. APAETP, in contrast to cystaphos and other sulfur-containing radioprotectors, does not cause spastic reactions in animals in toxic doses. The median lethal dose of APAETP in the molar expression is 1.5 times lower, and the optimum radioprotective dose almost three times lower than for cystaphos. Consequently, APAETP has almost twice the latitude of radioprotective action of cystaphos. APAETP, like cystaphos, exhibits a pronounced radioprotective effect not only at a high dose rate of γ radiation (355 R/min), but also at a comparatively low dose rate (10.7 R/min).

25460 (ERDA-tr—227) **Radiobiology.** Translation of *Radiobiologiya;* **16**: No. 4, 483-640(1976). 197p. Dep. NTIS $7.50.

Separate abstracts were prepared for the 33 papers presented in this issue of Radiobiologiya. (ERB)

25461 (ERDA-tr—227, pp 24-30) **Effects of prolonged exposure to divided doses of radiation on levels and biosynthesis of nucleic acids in the rat thymus.** Kisel'gov, E.I.; Mushkacheva, G.S. 1976. Translated from Radiobiologiya; 16: No. 4, 502-507(1976).

In Radiobiology.

Repeated daily exposure of rats to 50 R radiation for 2.5 months resulted in decreased weight of thymus, decreased number of cells and nucleic acid content per gram tissue. The rate of DNA biosynthesis was increased, starting with a cumulative dose of 250 R. The intensity of tracer uptake in RNA was at the control level up to a cumulative dose of 1500 R and thereafter it showed a 50 percent decrease. The demonstrated changes in nucleic acid metabolism are indicative of a change in proliferation and differentiation of thymus cells after repeated exposure to divided doses of radiation.

25462 **Synergism between neutron radiation and diethylstilbestrol in the production of mammary adenocarcinomas in the rat.** Shellabarger, C.J.; Stone, J.P.; Holtzman, S. (Brookhaven National Lab., Upton, NY). *Cancer Res.;* **36**: No. 3, 1019-1022(Mar 1976).

When young female A x C rats were given 9.6 rads of 0.43-MeV neutrons, 32 of 33 survived a 50-week follow-up period, 2 rats developed a total of 3 mammary adenocarcinomas, and 3 rats developed a total of 4 mammary fibroadenomas. For 25 rats implanted with a 20-mg pellet containing 5 mg diethylstilbestrol and 15 mg cholesterol, average survival was 284 days; 22 rats developed a total of 182 mammary adenocarcinomas, and 21 rats developed a pituitary tumor. When diethylstilbestrol was given 2 days before neutron radiation to 35 rats, the average survival was 239 days; 32 rats developed a total of 842 mammary adenocarcinomas, 1 rat developed a single mammary fibroadenoma, and 34 rats developed a pituitary tumor. All of the 31 control rats survived the 50-week study period, and none developed tumors. Twenty-one of the rats that received both diethylstilbestrol and neutron radiation and 1 rat that received only diethylstilbestrol exhibited a multiple mammary adenocarcinoma response with a range of 18 to 72 mammary adenocarcinomas per rat. These results were interpreted to mean that a synergistic interaction between diethylstilbestrol and neutron radiation on mammary adenocarcinoma formation occurs in terms of an earlier onset and a larger number of mammary adenocarcinomas. These results confirm and complement a previously reported synergistic interaction between diethylstilbestrol and X-radiation on mammary adenocarcinoma formation A x C female rats.

25463 **X-ray induced translocations in spermatogonia. II. Fractionation responses in mice.** Preston, R.J.; Brewen, J.G. (Oak Ridge National Lab., Tenn. (USA)). *Mutat. Res.;* **36**: No. 3, 333-344(Sep 1976).

The dose-response curve for reciprocal translocations induced by X-rays in spermatogonial stem cells and observed in the primary spermatocytes of mice is 'hump-shaped' with a maximum yield at about 600 R. To test the hypothesis that the decrease in yield with increasing dose above 600 R is a consequence of the different sensitivities of cells in different stages of the cell cycle to both cell killing and chromosome aberration induction, several fractionation experiments were carried out. A total dose of 2800 R was given in repeated doses of 400 R separated by 8-week intervals. The yield of translocations is that expected for additivity; for example, the yield at 1600 R is approximately equal to that for four separate 400-R doses. When a total dose (500 R) which gives a translocation yield on the ascending part of the dose-response curve is given as two equal fractions separated by intervals of 30, 90, or 150 min, the translocation yield decreases with increasing interval. However, when a total dose (1000 R) which would give a translocation yield on the descending part of the dose-response curve is given in two equal fractions separated by intervals of from 30 min to 6 weeks, the response is different; the translocation yield increases with intervals up to 18 h, then decreases with intervals up to 4 weeks, and finally increases again to a yield equal to additivity with an interval of 6 weeks. These changes in translocation yield with changes in interval between the two doses are explained in terms of the differential sensitivity of cells to killing and aberration induction in the different phases of the cell cycle, and by assuming that the cells surviving the first dose and repopulating the testis have different cycle characteristics from normal cells.

INVERTEBRATES

25464 (COO—2001-14) **Genetic effects of low x-ray doses. Progress report, October 1, 1975—September 30, 1976.** Abrahamson, S.; Meyer, H.U. (Wisconsin Univ., Madison (USA)). Sep 1976. Contract EY-76-S-02-2001. 19p. Dep. NTIS $3.50.

Experiments on dose-kinetics of x-ray induced sexlinked lethal mutations in Drosophila oogonia were continued. A wide range of doses was tested, with special emphasis on the low-dose range (20 to 500R). This year more data were added for O R, 200, 500, 1500R and some high doses. Oogonia of adult females were

irradiated, and only one daughter from each experimental parent-female was analyzed for a new lethal in her maternal X-chromosome. Thus no clusters of mutations of identical origin are encountered. The extensive accumulated data do not support the linearity principle, firmly established for recessive mutations induced in mature spermatozoa for high doses down to very low x-ray doses. A mathematical model describing the mutational yield is included that suggests that recessive mutations, like chromosome aberrations, result from both one-track and two-track events, with the latter playing an increasingly important role at higher doses.

BASIC STUDIES

25465 Effectiveness of tritium and ^{239}Pu in producing chromosome aberrations in Chironomus riparius. Blaylock, B.G.; Trabalka, J.R. (Oak Ridge National Lab., Tenn. (USA)). pp 45-49 of In Biological and environmental effects of low-level radiation. II. Vienna; IAEA (1976).

From Symposium on biological effects of low-level radiation pertinent to protection of man and his environment; Chicago, Ill., USA (3 Nov 1975).

The existing literature on relative biological effectiveness (RBE) indicates that the high linear energy transfer (LET) α radiation of ^{239}Pu is more effective in the production of cytogenetic effects in mammalian cells in tissue culture than are forms of low LET radiation. To compare the frequency of chromosome aberrations produced in the salivary gland chromosomes of Chironomus riparius by the low-energy β rays from tritium with those produced by the α radiation from ^{239}Pu, adults of C. riparius were introduced into cages containing concentrations of tritiated water ranging from 30 to 250 μCi/mlitre and into cages containing concentrations of ^{239}Pu ranging from 0.02 to 2 μCi/mlitre. Some larvae resulting from fertilized eggs were analysed for tritium and ^{239}Pu concentrations for dose calculation purposes while other larvae were allowed to develop into adults to produce an F_1 generation. F_1 larvae from the different concentrations of tritium and ^{239}Pu were analysed for chromosom aberrations. Aberrations were observed in larvae whose progenitors had developed in 30, 125 and 250 μCi/mlitre concentrations of tritiated water. A total of 295 F_1 larvae were analysed for chromosome aberrations from 0.02 μCi/mlitre concentrations of ^{239}Pu, but no aberrations were detected. The lowest calculated dose at which aberrations were detected for tritiated water was 180 rads. The dose calculated for the gonads of C. riparius in the ^{239}Pu concentration as 0.02 μCi/mlitre was approximately 120 rads. Based on the results obtained with tritiated water and the fact that the cytogenetic effects of α radiation are bigger than for other types of radiation, chromosome aberrations should have been detected at the dose rate calculated for the Chironomus in the plutonium culture. Thus, these preliminary data do not support a relatively high RBE for chromosome aberrations produced in the gonads of Chironomus exposed to chronic irradiation from ^{239}Pu.

RADIONUCLIDE EFFECTS - INTERNAL SOURCE

MAN

25466 (MLM—2365(OP)) **Mound Laboratory respiratory protection program.** Wright, E.M. (Mound Lab., Miamisburg, Ohio (USA)). 1976. Contract E(33-1)-GEN-53. 12p. (CONF-760967—1). Dep. NTIS $3.50.

From Loss prevention conference; St. Louis, Missouri, United States of America (USA) (27 Sep 1976).

The Mound Laboratory Respiratory Protection Program provides quality assurance to ensure that equipment is approved (U.S. Bureau of Mines) and adequate orientation and training, respirator fitting, maintenace of equipment, and records maintenance.

25467 (ORNL/NUREG/TM—6) **Correlation of radioactive waste treatment costs and the environmental impact of waste effluents in the nuclear fuel cycle: reprocessing light-water reactor fuel.** Finney, B.C.; Blanco, R.E.; Dahlman, R.C.; Hill, G.S.; Kitts, F.G.; Moore, R.E.; Witherspoon, J.P. (Oak Ridge National Lab., Tenn. (USA)). Oct 1976. Contract W-7405-ENG-26;NRC-INA-40-10-01-01-0. 164p. Dep. NTIS $6.75.

A cost/benefit study was made to determine the cost and effectiveness of radioactive waste (radwaste) treatment systems for decreasing the release of radioactive materials from a model nuclear fuel reprocessing plant which processes light-water reactor (LWR) fuels, and to determine the radiological impact (dose commitment) of the released materials on the environment. The study is designed to assist in defining the term as low as reasonably achievable in relation to limiting the release of radioactive materials from nuclear facilities. The base case model plant is representative of current plant technology and has an annual capacity of 1500 metric tons of LWR fuel. Additional radwaste treatment systems are added to the base case plant in a series of case studies to decrease the amounts of radioactive materials released and to reduce the radiological dose commitment to the population in the surrounding area. The cost for the added waste treatment operations and the corresponding dose commitments are calculated for each case. In the final analysis, radiological dose is plotted vs the annual cost for treatment of the radwastes. The status of the radwaste treatment methods used in the case studies is discussed. Much of the technology used in the advanced cases is in an early stage of development and is not suitable for immediate use. The methodology used in estimating the costs, and the radiological doses, detailed calculations, and tabulations are presented in Appendix A and ORNL-4992. This report is a revision of the original study (ORNL/TM-4901).

25468 (UCID—17313) **Derivation of plant-soil relationships for dose assessment on Bikini Atoll.** Colsher, C.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Nov 1976. Contract W-7405-ENG-48. 37p. Dep. NTIS $4.00.

A radiological survey of the terrestrial environment of Bikini and Eneu Islands (Bikini Atoll) was conducted in June 1975 to evaluate the potential radiation dose to the returning Bikini population. This report presents measurements of the radionuclide concentration in soil profiles and in dominant species of edible and nonedible indicator plants and describes the use of these data to derive relationships to predict the plant uptake of radionuclides from soil. Soil-plant concentration factors together with leaf-leaf and fruit-leaf concentration ratios for indicator and edible plant species from the same area are calculated to quantitatively assess and compare the uptake of ^{90}Sr, ^{137}Cs, and $^{239}w240$Pu. In general, the concentration factors for ^{137}Cs in terrestrial vegetation are greater than those for ^{90}Sr and the concentration factors for both these nuclides exceed those for $^{239}w240$Pu by ten to one hundred-fold. Uptake of ^{90}Sr and $^{239}w240$Pu by fruit is less than that by mature leaves; however, the opposite is true for ^{137}Cs. The relative contribution of the individual plant species to the internal dose to man varies with the nuclide. The use of concentration factors and concentration ratios to predict nuclide concentrations in fruit from those in soil or leaves is prescribed.

NUCLIDE KINETICS AND TOXICOLOGY

MAN

REFER ALSO TO CITATION(S) 25306

25469 (UCRL—52176) **Plutonium concentrations in dietary and inhalation pathways at Bikini and New York.** Robison, W.L.; Noshkin, V.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 27 Sep 1976. Contract W-7405-ENG-48. 21p. Dep. NTIS $3.50.

This report assesses the plutonium intake via inhalation and ingestion for residents of New York and residents of Bikini Atoll. Based on inhalation and ingestion intake, the plutonium transferred to urine would be roughly seven times greater at Bikini than at New York. This ratio compares with data reported to the authors showing urine samples from Bikini residents had about ten times the Pu of urine samples from New York residents. The comparison of these ratios indicates that differences in the levels of intake in the New York and Bikini populations can account for the relative difference between the Pu concentrations observed in urine samples from the two locations.

ANIMALS

REFER ALSO TO CITATION(S) 25306, 25307

25470 Carbon-11 labeled aliphatic amines in lung uptake and metabolism studies: potential for dynamic measurements in vivo. Fowler, J.S.; Gallagher, B.M.; MacGregor, R.R.; Wolf, A.P. (Brookhaven National Lab., Upton, NY). *J. Pharmacol. Exp. Ther.;* **198**: No. 1, 133-145(1976).

In order to assess the potential utility of amines labeled with short-lived nuclides as agents for lung imaging and function studies in humans, a series of aliphatic amines (C_4—C_{10} and C_{13}) labeled with carbon-11 (T/sub 1/2/ = 20.4 minutes), which decays by the emission of body-penetrating radiation, has been used as a model for studying some basic parameters affecting amine uptake and metabolism by the lung and other tissues in mice. The lung uptake (percentage of dose per organ) of aliphatic amines at 1 minute increased from 2.18 +- 0.13% for butylamine to 13.33 +- 0.84% for tridecylamine. Partition coefficients (between n-octanol and pH = 7 buffer) were measured for the C_4 through C_{10} amines and for octanoic acid and octanenitrile. Within the amine series, the partition coefficient correlated with lung uptake. A comparison of a series of compounds all having a carbon chain length of eight but with different functional groups (-NH_2, -C identical with N, -CO_2H, -OH) showed that the amino group as well as the relatively lipophilic alkyl group were required for lung specificity. The ^{11}C-aliphatic amines were rapidly

metabolized via monoamine oxidase (ultimately to $^{11}CO_2$). Non-amine metabolites in blood and lungs at 5 minutes postinjection were 95 and 50%, respectively. Pretreatment of mice with iproniazid and with pargyline decreased $^{11}CO_2$ excretion, and iproniazid significantly increased the radioactivity retained by the brain, lungs and liver at 15 minutes. The rate of $^{11}CO_2$ excretion depended on carbon chain length ($C_4 < C_5U\ C_6 < C_7 < C_8 < C_9 < C_{10} < C_{13}$).

25471 Comparative metabolism of radionuclides in mammals. XI. Retention of ^{113}Sn in the mouse, rat, monkey and dog. Furchner, J.E.; Drake, G.A. (Los Alamos Scientific Lab., N.Mex. (USA)). *Health Phys.;* **31**: No. 3, 219-224(Sep 1976).

Stannous chloride was injected by oral (IG), intraperitoneal (IP) and intravenous (IV) routes into mice, rats and African white-tailed rats and by IG and IV routes into monkeys and dogs. Less than 5% was absorbed from the gut. There was much similarity in retention patterns following parenteral administration, and the small amount absorbed from the gut in conjunction with the discontinuous nature of fecal excretion resulted in similar patterns after ingestion of tin. Bone was the chief site of tin deposition. The biological inertness of tin results in a low order of toxicity. The radiation protection guides set by the International Commission on Radiological Protection in 1960 appear to be adequate in view of the data presented.

PLANTS

REFER ALSO TO CITATION(S) 25305, 25306

THERMAL EFFECTS

VERTEBRATES

REFER ALSO TO CITATION(S) 25363

25472 Effects of increasing temperature on social behaviour in territorial groups of pumpkinseed sunfish, Lepomis gibbosus. Power, M.E. (Boston Univ.); Todd, J.H. *Environ. Pollut. (London);* **10**: No. 3, 217-223(Apr 1976).

To study the effect of thermal stress on their social behavior, ten territorial groups of pumpkinseed sunfish, Lepomis gibbosus, were subjected to a 1°C temperature increase every other day until they succumbed. Social behavior remained remarkably unchanged by thermal stress until nearly lethal levels. As temperature rose, ritualized behaviors increased in frequency, then fell off, probably reflecting changes in general activity. Behavioral and physiological signs of stress appeared from 31 to 38°C. Events during these social breakdowns are described and compared with the response of two other freshwater fishes with different social organizations subjected to the same thermal regime. (auth)

CHEMICALS METABOLISM AND TOXICITY

REFER ALSO TO CITATION(S) 25114, 25115

CELLS

REFER ALSO TO CITATION(S) 25437

PLANTS

REFER ALSO TO CITATION(S) 25304, 25310

25473 (BNL—50575) **Acid rain research program. Annual progress report, September 1975—June 1976.** Evans, L.S.; Raynor, G.S. (Brookhaven National Lab., Upton, N.Y. (USA)). Sep 1976. 67p. Dep. NTIS $4.50.

The aims of the research program are: (a) to observe the minimum threshold dose of simulated acid rain to produce visual and histological effects on plant foliage, (b) approach threshold limits of simulated sulfate acid rain that affect plant growth and reproduction, and (c) to measure chemical and meteorological parameters of incident rain. Acute leaf injury to several plant species resulted from exposure of foliage to simulated sulfate acid rain of pH level 2.3 to 2.9. Only slight injury occurred at 3.1. Scanning electron micrographs showed that injury to upper leaf surfaces occurred mostly at the base of trichomes (leaf hairs) and near stomata. An association of lesion development near vascular tissue was also noted. Histologically, lesions are characterized by an initial collapse of the epidermis with eventual lysis and collapse of more internal leaf tissues on the upper leaf surface of pinto beans which complemented detailed descriptions of visual lesion development after daily exposures to simulated rain. Initial experiments with gametophytes of Pteridium aquilinum show that reproduction of this fern species is very sensitive to solutions of pH 5.2 while vegetative development is not affected at pH levels of 2.2. Initial rain samples from the sequential sampler have been obtained. Initial portions of rain events exhibit a pH near 3.0 in some cases. More complete chemical analyses are anticipated.

INVERTEBRATES

REFER ALSO TO CITATION(S) 25310

VERTEBRATES

REFER ALSO TO CITATION(S) 25113, 25310, 25330, 25338

25474 (COO—2502-8) **Effect of arsenic on the thermal tolerance and survival of newly hatched muskellunge fry (Esox masquinongy).** Paladino, F.V. (State Univ. of New York, Buffalo (USA). Dept. of Biology). 1976. Contract EY-76-S-02-2502. 51p. Dep. NTIS $4.50. Thesis.

Newly hatched muskellunge fry were raised in tanks containing 0.00, 0.05, 1.0 and 5.0 ppM arsenic as sodium arsenite ($NaAsO_2$) at a temperature of 15°C (+-0.5°C) and a photoperiod of 12 hours of light alternating with 12 hours of dark. Temperature tolerance of fry, Critical Thermal Maximum, (CTM), was significantly reduced by exposure to arsenic. Fry raised at arsenic concentrations of 0.05 ppM or greater suffered 100 percent mortality during or shortly after swim-up. Control fry had a sharp drop in CTM during swim-up, became active feeders and continued to develop normally.

25475 Mutagenicity tests with cadmium in the mouse. Gilliavod, N.; Leonard, A. (CEN, Mol, Belgium). *Toxicology;* **5**: 43-47(1975).

The testicle is known to be the critical organ in acute exposure of experimental mammals to cadmium. Such treatment results in temporary sterility and, very often, in the appearance of testicular interstitial cell tumors. The present experiments were performed to determine whether such deleterious effects on the male reproductive organs involved any genetic hazards for the surviving germ cells. The administration of 1.75 mg/kg cadmium chloride to male mice did not increase the dominant lethals during the first three weeks after treatment and failed to induce translocation in the F_1 male offspring. No chromosome rearrangement was observed in the treated males after i.p. injection of 0.5, 1.75 or 3.0 mg/kg cadmium chloride.

25476 Tobacco smoke inhalation studies in rats. Kendrick, J.; Nettesheim, P.; Guerin, M.; Caton, J.; Dalbey, W.; Griesemer, R.; Rubin, I.; Maddox, W. (Oak Ridge National Lab., TN). *Toxicol. Appl. Pharmacol.;* **37**: 557-569(1976).

The feasibility of using rats in a bioassay for the effects of fresh tobacco smoke was investigated by a series of acute and long-term inhalation studies. Female SPF rats were exposed to 10 percent smoke from standard test cigarettes on an intermittent smoke machine. [^{14}C]dotriacontane was used as label for the smoke particles, and it was calculated that under the described exposure conditions 0.3—0.4 mg of total particulate matter was retained in the rats from exposure to the smoke of one cigarette. This is similar to the dose sustained by hamsters under identical conditions. It was found that respiratory minute volume is decreased to 25 percent of normal during smoke exposure. The great sensitivity of rats to smoke toxicity could be overcome by gradual adaptation. This made it possible to chonically expose rats to 7 and 10 cigarettes per day with a death rate of 10 and 20 percent, respectively, at 12 months, and of 18 and 53 percent, respectively, at 18 months of exposure. This represents a far better survival rate at high smoke exposure levels for rats (or hamsters) than has ever been reported in the literature. Smoke-induced pathological changes were observed in the respiratory tract only. These included mild focal hyperplasia of the upper airways, bronchiolitis of the terminal bronchioles, and severe focal alveolitis.

25477 Acute effects of cadmium on Ictalurus punctatus (catfish). Smith, B.P.; Hejtmancik, E.; Camp, B.J. (Texas A and M Univ., College Station). *Bull. Environ. Contam. Toxicol.;* **15**: No. 3, 271-277(1976).

Catfish, exposed to cadmium in ambient water, accumulated cadmium in the kidney and liver, with the kidney accumulating more of the higher concentration of cadmium. In 40 percent of the brains no cadmium was detected, and only trace amounts detected in the others. Although the amount of cadmium accumulated in the kidney and liver increased with exposure, the biological magnification of cadmium decreased. Therefore, tissue levels of cadmium cannot be correlated with ambient cadmium levels. None of the hematological constituents assayed appeared to be valuable as a diagnostic test for cadmium exposure.

25478 Uptake of ^{125}I-iododeoxyuridine in mouse organs during deuteration of body water: evidence for a thymus-specific effect. Laissue, J.A.; Slatkin, D.N. (Brookhaven National Lab., Upton, NY). *Life Sci.;* **19**: 641-648(1976).

The effects of body water deuteration on mammalian DNA synthesis in vivo during the deuterium equilibration period in the

body were studied. Young adult mice were given 15 percent or 30 percent D_2O in the drinking water for 4, 10 or 21 days. Control mice were given distilled water. Eighteen hours prior to sacrifice, ^{125}IUdR, a conveniently monitored synthetic analogue of the DNA precursor thymidine, was injected intravenously. Although neither radioiodine activity of the total body nor body weight varied significantly among the three groups, thymic radioactivity per g tissue was significantly lower in mice given 30 percent D_2O and, to a lesser extent, in mice given 15 percent D_2O than in the control group. In contrast, intestine and hemopoietic bone marrow displayed minor changes in ^{125}IUdR incorporation. This reduction of ^{125}IUdR incorporation is discussed in relation to the particular importance of thymidine reutilization in the thymus.

MAN

REFER ALSO TO CITATION(S) 23950, 25284, 25338, 25361, 25404

25479 (COO—2874-15) **SIMS three year study on statistics and environmental factors in health. Technical progress report No. 1.** (SIAM Inst. for Mathematics and Society, New Canaan, Conn. (USA)). Dec 1976. Contract EY-76-S-02-2874. 37p. Dep. NTIS $4.00.

Progress is reported for the activities of the Siam Institute for mathematics and society (SIMS), Columbia University, and Stanford University. The SIMS report is concerned with the use of animal experiments in establishing tolerance limits for human exposure to environmental toxicants; valid assessment of the health consequences of occupational and other specialized toxic exposures; mathematical theories for the kinetics of carcinogenesis; data coding, storage, access, and analysis, relationship between air pollution and respiratory diseases; and air pollution assessment. The Columbia University report is concerned with development of statistical methods and models for describing the effects of the environment, measured by pollution and weather variables, on respiratory diseases. The Stanford University report is concerned with spatial distribution of air pollutants, relation of pollutant concentrations to morbidity and mortality statistics, and other topics. (HLW)

25480 Lead distribution in soft tissues of Baltimore residents, 1973. Poklis, A.; Freimuth, H.C. (Office of the Chief Medical Examiner, Baltimore). *Bull. Environ. Contam. Toxicol.;* **15**: No. 3, 311-315(1976).

An analysis of the liver, lung, kidney, and pancreas of Baltimore residents is presented. The highest lead concentrations were found in the liver and kidney. The relatively high levels of lead in these two organs is probably related to their excretory functions. It appeared that age, per se, was not a significant factor in evaluating the lead content of the liver, kidney, lung or pancreas in healthy adults.

OTHER ENVIRONMENTAL POLLUTANT EFFECTS

25481 (ANL—76-XX-16) **Noise pollution from expressways.** Vaughan, R.J.; Huckins, L. (Argonne National Lab., Ill. (USA); Chicago Univ., Ill. (USA). Center for Urban Studies). Jun 1976. Contract W-31-109-ENG-38;NSF-AG-352;NSF-GI-32989A2. 9p. Dep. NTIS $3.50.

This paper provides an economic analysis of three noise abatement strategies designed to interrupt the path of noise between highways and residential areas, and makes some abatement policy suggestions.

25482 (EPRI-EA—331) **Effects of electric fields on large animals. Interim report.** Gillis, M.F.; Allen, C.H.; Beamer, J.L.; Richardson, R.L.; Kaune, W.T.; Jeffs, T.W. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Dec 1976. 76p. Dep. NTIS $5.00.

This report briefly describes progress toward the establishment of a colony of Hanford Miniature Swine (HMS) for long-term study of the effects of 60-Hz electric fields on development and physiologic function. Major tasks to date included design and erection of an electrode system to provide uniform, vertical fields of large magnitude, design of nonconducting housing meeting criteria of durability and electrical acceptability, and establishment of a breeding protocol for the first generation of HMS.

25483 Lack of effect of extremely low frequency electric and magnetic fields on roots of Vicia faba. Miller, M.W.; Reddy, M.M.; Yettewich, G.R.; Kaufman, G.E. (Univ. of Rochester, NY). *J. Exp. Bot.;* **16**: 83-88(1976).

Roots of Vicia faba were exposed for up to six days to 75 Hz magnetic fields up to 17 gauss and to 75 Hz electric fields of 10V/m. These fields are approximately 85 times and 100 times, respectively, the fields which would result from a buried extra low frequency antenna of the design proposed for the Navy's Project Sanguine. No differences in growth or mitotic index were observed between control and exposed roots. Also, no chromosomal anomalies were observed.

HEALTH AND SAFETY

25484 (ERDA—76-45-1) **Occupancy-use readiness manual: safety considerations.** Nertney, R.J.; Clark, J.L.; Eicher, R.W. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). Sep 1975. Contract E(10-1)-1375. 43p. (SSDC—1). Dep. NTIS $4.00.

Originally, this guideline manual was designed for use by MORT (Management Oversight and Risk Tree) certified system safety analysts. This revision represents an attempt to present sufficient additional detail and accompanying narrative for non-MORT users to apply this document's principles in preparation for occupancy and use of new or modified facilities. However, complex facilities or operations can present a more involved analysis, in which case this document may be inadequate for a non-MORT user. It is beyond the scope of this guide to review all of the MORT lessons which could apply to an involved analysis. In such situations, a MORT certified individual should perform the analysis or, as a minimum, should serve as consultant.

GEOSCIENCES

REFER ALSO TO CITATION(S) 24864

GEOLOGY AND HYDROLOGY

25485 (NP—21220) **Bibliography and index of Colorado geology, 1875 to 1975.** (Geological Survey, Denver, Colo. (USA)). 1976. 502p. Colorado Geological Survey, Denver, CO $7.50.

This bibliography encompasses the fields of stratigraphy, structure and tectonics, mining and economic geology, petrology, mineralogy, historical geology, paleontology, geomorphology, geochemistry, hydrology, engineering and environmental geology, geophysics, and archaeology. The volume consists of 4 sections: (1) bibliography, (2) subject index, (3) county index, and (4) rock-unit index. (MHR)

GEOPHYSICS

25486 (UCRL—78374) **Seismic evaluation of critical facilities at the Lawrence Livermore Laboratory.** Murray, R.C.; Tokarz, F.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Jun 1976. Contract W-7405-ENG-48. 9p. (CONF-770103—1). Dep. NTIS $3.50.

From 6. world earthquake conference; New Delhi, India (10 Jan 1977).

The performance of critical facilities at the Lawrence Livermore Laboratory (LLL) are being evaluated for severe earthquake loading. Facilities at Livermore, Site-300 and the Nevada Test Site are included in this study. These facilities are identified, the seismic criteria used for the analysis are indicated, the various methods used for structural analysis are discussed and a summary of the results of facilities analyzed to date are presented.

MAGMATISM, VOLCANOLOGY, AND IGNEOUS PROCESSES

25487 (LA-UR—76-1708) **Evolution of silicic magma chambers and their relationship to basaltic volcanism.** Eichelberger, J.C.; Gooley, R. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 35p. (CONF-760872—1). Dep. NTIS $4.00.

From Symposium on the Crust; Vail, Colorado, United States of America (USA) (2 Aug 1976).

Silicic volcanism is commonly preceded by eruption of basalt. Similarly, the earliest phases of granitic plutonic complexes are often gabbro or diorite. Basalt magma must play a role in the initiation of a large silicic magma system, but three lines of evidence suggest that basalt magma also enters silicic chambers and influences their further evolution. These are: contemporaneous basalt vents flank silicic volcanic centers; thermal models of silicic bodies suggest that their heat must be replenished to maintain them in the upper crust for their observed life span; and petrologic data indicate that mafic clots and cognate xenoliths common in granodiorite and andesite represent basalt magma quenched within active silicic magma chambers.

Phase assemblages in volcanic rocks and bulk composition of volcanic and plutonic rocks in suites of this type show that much of the variation in erupted or crystallized end products is due to this interaction of basaltic and rhyolitic magmas. It is proposed that basalt magma from the upper mantle provides heat for generating rhyolitic melt in the lower crust, and that the resulting rhyolite magma body continues to receive injections of basalt as it rises through the crust. Implications of this model are discussed.

GEOCHEMISTRY

REFER ALSO TO CITATION(S) 25143

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

COSMIC RADIATION

REFER ALSO TO CITATION(S) 25251, 25489

STARS

25488 (UCRL-Trans—11206) **Numerical procedure for the calculation of nonsteady spherical shock fronts with radiation.** Winkler, K.H. (Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.)). Jul 1976. Translation of MPI-PAE/ASTRO—90. 61p. Dep. NTIS $4.50.

Thesis.

The basis of the numerical method is an implicit difference scheme with time backward differences to a freely moving coordinate system. The coordinate system itself is determined simultaneously with the iterative solution of the physical equations as a function of the physical variables. Shock fronts, even nonsteady ones, are calculated as discontinuities according to the Rankine—Hugoniot equations. The radiation field is obtained from the two-dimensional, static, spherically symmetric transport equation in conjunction with the time-dependent one-dimensional moment equations. No artificial viscosity of any type is ever used. The applicability of the method developed is demonstrated by an example involving the calculation of protostar collapse. 11 figures.

QUASI-STELLAR, RADIO, AND X-RAY SOURCES

REFER ALSO TO CITATION(S) 25713

SOLAR PHENOMENA

REFER ALSO TO CITATION(S) 25654

25489 (BNL—21837) **Report on the Brookhaven solar neutrino experiment.** Davis, R. Jr.; Evans, J.C. Jr. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract E(30-1)-16. 17p. (CONF-760973—1). Dep. NTIS $3.50.

From International seminar on active processes on the sun and the solar neutrino problem; Leningrad, Union of Soviet Socialist Republics (USSR) (22 Sep 1976).

This report is intended as a brief statement of the recent developments and results of the Brookhaven Solar Neutrino Experiment communicated through Professor G. Kocharov to the Leningrad conference on active processes on the sun and the solar neutrino problem. The report summarizes the results of experiments performed over a period of 6 years, from April 1970 to January 1976. Neutrino detection depends upon the neutrino capture reaction $^{37}Cl(\nu,e^-)^{37}Ar$ producing the isotope ^{37}Ar (half life of 35 days). The detector contains 3.8×10^5 liters of C_2Cl_4 (2.2×10^{30} atoms of ^{37}Cl) and is located at a depth of 4400 meters of water equivalent (m.w.e.) in the Homestake Gold Mine at Lead, South Dakota, U.S.A. The procedures for extracting ^{37}Ar and the counting techniques used were described in previous reports. The entire recovered argon sample was counted in a small gas proportional counter. Argon-37 decay events were characterized by the energy of the Auger electrons emitted following the electron capture decay and by the rise-time of the pulse. Counting measurements were continued for a period sufficiently long to observe the decay of ^{37}Ar.

25490 **Solar neutrinos and neutrino mixing.** Nussinov, S. (Inst. for Advanced Study, Princeton, NJ). *Phys. Lett.;* **63**: No. 2, 201-203(19 Jul 1976).

The recent suggestion that mixing of many neutrino types accounts for the solar neutrino puzzle is discussed. It is found that in general the suppression due to mixing of k species is by less than a factor k.

GALAXIES

25491 **Observations of interstellar CH at 9 cm wavelength.** Gardner, F.F.; Robinson, B.J.; Sinclair, M.W. (CSIRO, Epping, Australia). *Aust. J. Phys.;* **29**: 211-226(1976).

The 9 cm ground-state lines of CH have been observed in southern galactic sources, mainly HII regions. The F = 0 to 1 transition at 3264 MHz has been detected in emission in 16 sources; the F = 1 to 1 transition at 3335 MHz has been seen in absorption in 5 sources and in emission in 2 others. Where the F = 1 to 1 transition is in absorption the transition temperature is positive and below about 100°K. The F = 0 to 1 transition is generally inverted, with a transition temperature between -10 and 0°K. The column densities of CH are in the vicinity of 10^{14} cm^{-2}, slightly below those for OH but many times those for H_2CO. There is no correlation between apparent optical depths of CH and those for OH or H_2CO absorption. There is also no enhancement of CH in the dense molecular clouds near the center of the Galaxy.

PLANETARY PHENOMENA

25492 (UCRL—52000-76-11, pp 1-5) **Taking the moon's internal temperature.** Duba, A.G. Nov 1976.

In Energy and technology review.

LLL geophysicists were instrumental in resolving a serious discrepancy between lunar magnetic-field data and melting studies of lunar basalts brought back from the Moon by Apollo astronauts. Estimates of the subsurface temperatures, based on lunar electrical conductivity measurements and laboratory experiments, were hundreds of degrees below those given by models using known melting points of various minerals. The work uncovered a basic flaw in previous measurements. New measurements under more realistic conditions brought the electrical-conductivity temperature estimates into agreement with temperatures derived from melting experiments. This same work also contributed to in situ coal gasification studies; to ERDA's dry, hot-rock geothermal effort; and to a program of monitoring for seismic evidence of clandestine nuclear testing. 4 figures.

25493 **Interplanetary shocks seen by Ames plasma probe on Pioneer 6 and 7 .** Abraham-Shrauner, B.; Yun, S.H. (Washington Univ., St. Louis). *J. Geophys. Res.;* **81**: No. 13, 2097-2102(1 May 1976).

Interplanetary shocks and discontinuities observed by the Ames Research Center plasma probe on Pioneer 6 and 7 are analyzed with Goddard Space Flight Center magnetometer data. Several shock normals are used for the MHD model of a shock where the mixed data shock normals, which use plasma and magnetic field data, give the best agreement with the theoretical requirements. The requirements are the satisfaction of the Rankine-Hugoniot conservation equations across the shock where angles (predicted theoretically from the conservation equations) between certain combinations of plasma and magnetic field data vectors in the shock normals are explicitly checked. The results for the August 29, 1966, shock are compared with previous results.

ATMOSPHERIC PHYSICS

25494 **Relative influence of stratospheric aerosols on solar and longwave radiative fluxes for a tropical atmosphere.** Luther, F.M. (Univ. of California, Livermore). *J. Appl. Meteorol.;* **15**: No. 9, 951-955(Sep 1976).

The solar and longwave radiative effects of a stratospheric aerosol layer between 18 and 22 km are compared for a tropical atmosphere. The changes in the daily mean solar and longwave radiative fluxes above and below the aerosol layer are computed for two particle size distributions and as a function of the albedo of the earth's surface. The changes in the solar and longwave fluxes above the aerosol layer are found to be comparable in magnitude. In the troposphere, the reduction in the incoming solar radiation (cooling) is several times greater than the increase in the downward longwave radiation (warming), the difference decreasing with increasing surface albedo.

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

BEAMS AND THEIR REACTIONS

REFER ALSO TO CITATION(S) 25499

25495 (CONF-760922—14) **X-ray photoelectron spectroscopy of 5f electrons in dioxides of neptunium and plutonium.** Veal, B.W.; Lam, D.J.; Diamond, H. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 9p. Dep. NTIS $3.50.

From International conference on magnetism; Amsterdam, Netherlands (6 Sep 1976).

The 5f electron spectra in NpO_2 and PuO_2 were studied by XPS. Using intensity measurements and multiplet structure, the configuration $5f^3$ was assigned to NpO_2. Although NpO_2 exhibits anamolous magnetic behavior similar to TmSe (a valence fluctuation system), XPS results do not support the valence fluctuation model for NpO_2.

25496 (CONF-761059—6) **Accelerator based atomic physics experiments: an overview.** Moak, C.D. (Oak Ridge National Lab., Tenn. (USA)). 1976. Contract W-7405-ENG-26. 5p. Dep. NTIS $3.50.

From 4. annual conference on the use of small accelerators; Denton, Texas, United States of America (USA) (25 Oct 1976).

Atomic Physics research with beams from accelerators has continued to expand and the number of papers and articles at meetings and in journals reflects a steadily increasing interest and an increasing support from various funding agencies. An attempt will be made to point out where interdisciplinary benefits have occurred, and where applications of the new results to engineering problems are expected. Drawing from material which will be discussed in the conference, a list of the most active areas of research is presented. Accelerator based atomic physics brings together techniques from many areas, including chemistry, astronomy and astrophysics, nuclear physics, solid state physics and engineering. An example is the use of crystal channeling to sort some of the phenomena of ordinary heavy ion stopping powers. This tool has helped us to reach a better understanding of stopping mechanisms with the result that now we have established a better base for predicting energy losses of heavy ions in various materials.

25497 (CONF-761059—17) **Dissociation of fast molecular-ion beams in thin foils.** Gemmell, D.S.; Vager, Z.; Zabransky, B.J. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 6p. Dep. NTIS $3.50.

From 4. annual conference on the use of small accelerators; Denton, Texas, United States of America (USA) (25 Oct 1976).

Distributions in angle and in energy were measured for the break-up fragments produced when fast (approximately MeV/nucleon) beams of molecular ions (H_2i, HeH^+, OH^+, etc.) bombard thin foil targets. Studies were made using both amorphous and crystalline targets. The results display some dramatic departures from expectations based on a simple Coulomb explosion picture in which a cluster of nuclei stripped of their binding electrons move apart under the influence of their mutual Coulomb repulsion. An explanation for these differences is offered in terms of an interaction between the projectiles and polarization oscillations induced in the target by the passage of the clusters. A theoretical model is outlined which not only accounts well for the total electronic stopping power of the solid (due to the braking effect of the polarization charges) but also gives good agreement with the experimental results on dissociation of fast molecular-ion beams. Data obtained for the heavier molecules show interesting possibilities for determining effective charges inside solids.

25498 (SLA—73-0974) **REEFER: a digital computer program for the simulation of high energy electron tubes.** Boers, J.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Nov 1976. Contract E(29-1)-789. 46p. Dep. NTIS $4.00.

A digital computer program for the simulation of very high-energy electron and ion beams is described. The program includes space-charge effects through the solution of Poisson's equation and magnetic effects (both induced and applied) through the relativistic trajectory equations. Relaxation techniques are employed while alternately computing electric fields and trajectories. Execution time is generally less than 15 minutes on a CDC 6600 digital computer. Either space-charge-limited or field-emission sources may be simulated. The input data is described in detail and an example data set is included.

ATOMIC AND MOLECULAR PROPERTIES

REFER ALSO TO CITATION(S) 25513

25499 (LBL—5718) **Precision measure of the ground state g/sub J/ of atomic lithium.** Oezmen, A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 30 Sep 1976. Contract W-7405-ENG-48. 99p. Dep. NTIS $5.50.

Thesis.

A high precision measurement of the g/sub J/ factor of lithium in the $^2S/sub\ 1/_2$ ground state is described. The measurement was made by comparing resonances in ^{133}Cs and ^7Li at 4041 Gauss. The C field in this work is homogenized over a space of 4" long and $1/_2ww$ high. The final result obtained using single hairpin flop-in transitions taken at four possible relative orientations of the hairpin and the magnetic field is: g/sub J/(^7Li) = -2.0023002(21). Preliminary experimental studies using separated oscillatory fields at two different separations of the hairpins have given insight into the changes required in order to improve upon the g/sub J/ measurement. In addition investigation of the theoretical line shapes of the separated oscillatory field method with various parameters is included.

POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES

REFER ALSO TO CITATION(S) 25517

25500 (BNL—21937) **Approximate method for calculating the lifetime of positrons trapped by lattice defects.** Welch, D.O.; Lynn, K.G. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract EY-76-C-02-0016. 8p. (CONF-761027—4). Dep. NTIS $3.50.

From International conference on properties on atomic defects on metals; Argonne, Illinois, United States of America (USA) (18 Oct 1976).

A method which takes account of core as well as valence electrons is presented for theoretically estimating the life-time of positrons trapped in lattice defects. The method is illustrated by calculations for vacancies and divacancies in aluminum.

COLLISION PHENOMENA

REFER ALSO TO CITATION(S) 25138, 25506

25501 (CONF-761059—10) **Electron capture by multicharged ions.** Crandall, D.H. (Oak Ridge National Lab., Tenn. (USA)). 1976. Contract W-7405-ENG-26. 8p. Dep. NTIS $3.50.

From 4. annual conference on the use of small accelerators; Denton, Texas, United States of America (USA) (25 Oct 1976).

Recent research on electron transfer between multicharged ions and neutral targets is reviewed. The needs of astrophysics and thermonuclear fusion coupled with the availability of beams of slow multicharged ions have stimulated interest in these collisions. Data available on systems such as Ar/sup i+/ + Ar and Fe/sup i+/ + H indicate that cross sections as large as $10^{-14}\ cm^2$ occur for transfer of an electron at collision velocities near and below the velocities of electrons in the atoms. In some cases, quantitatively correct predications of the cross sections have been based on a quasi-molecular model of the colliding system. This paper presents some of the available data, data needs, and comparison of experiment and theory for electron transfer at low collision velocities. A similar review was recently given by Salzborn, but already significant new results have been obtained.

25502 (COO—1265-183, pp 99-106) **Projectile charge dependence of L-subshell ionization cross section ratios for heavy elements.** Li, T.K.; Clark, D.L.; Greenlees, G.W. Jan 1977.

In John H. Williams Laboratory of Nuclear Physics, University of Minnesota annual report, 1976.

L-subshell ionization cross section ratios for incident p, alpha, ^{12}C and ^{16}O at .5 to 6.0 MeV/N are investigated for tantalum, gold, bismuth and uranium. (SDF)

25503 (COO—1265-183, pp 107-112) **L-subshell ionization cross sections for uranium by charged particle bombardment.** Li, T.K.; Clark, D.L.; Greenlees, G.W. Jan 1977.

In John H. Williams Laboratory of Nuclear Physics, University of Minnesota annual report, 1976.

L-subshell ionization cross sections for bombardment of uranium by p, alpha, ^{16}O, and ^{12}C are compared with plane wave Born approximation calculations. (SDF)

25504 (COO—2542-4) **Inelastic molecular collisions: application of theoretical methods to problems relevant to laser operation. Progress report, February 1, 1976—November 1, 1976.** Rabitz, H. (Princeton Univ., N.J. (USA). Dept. of Chemistry). 1976. Contract EY-76-S-02-2542. 32p. Dep. NTIS $4.00.

The main goals of this research are to develop and implement various techniques for describing molecular collision phenomena. The aim is to achieve sufficient understanding of these processes such that collision rates of interest (e.g., for gas lasers) may be reliably estimated. Several areas of research are being explored to achieve this goal. The specific molecular systems of H_2-H_2, HF-He, HF-Ar and HCl-Ar are being studied as examples of inelastic molecular collisions. In addition, during the past year further theoretical development was conducted in the area of decomposition techniques and effective Hamiltonian theory. Considerable progress was made in these various areas during the past year. This research represents a collaboration under this contract and with Professor R. Conn, University of Wisconsin, under contract AT(11-1)-2555. Much of the material in this report has been published or is presently in press (items indicated by * in the references).

25505 (UCRL—78551) **Non-linear effects in the production of x-ray emitting states for projectiles moving in gas, foil, and solid targets.** Matthews, D.L.; Fortner, R.J. (California Univ., Livermore (USA).

Lawrence Livermore Lab.). Oct 1976. Contract W-7405-ENG-48. 9p. (CONF-761059—11). Dep. NTIS $3.50.

From 4. annual conference on the use of small accelerators; Denton, Texas, United States of America (USA) (25 Oct 1976).

High resolution x-ray spectral measurements are used to determine the relative intensity of x-ray transitions for ions such as fluorine excited in collisions with various pressure Ne, Ar and Kr gas targets, thin carbon foils and a thick carbon slab. The relative intensities are observed to be nonlinearly dependent on both target density and incident charge Z. These effects are attributed to strong collisional quenching of initial states by subsequent large impact parameter collisions. The data permit extraction of the total quenching cross sections (sigma/sub Q/) for fast fluorine ions in various states. A strong enhancement of the relative intensity of the 2^3P_1 is observed for F^{7+} and O^{6+} projectiles. This strong enhancement is attributed to selective excitation of metastable states in the beam, i.e., 1s2s $^3S_1$, into the 1s2p $^3P_1$ state. Finally, the data for foil and solid targets are used to obtain information on the excitation states of ions moving in solids.

ATOMIC AND MOLECULAR THEORY

REFER ALSO TO CITATION(S) 25601

25506 (COO—2557-1) **Theoretical research in physics of highly ionized atoms. Final report, March 1, 1975—June 30, 1976.** Bardsley, J.N.; Norcross, D.W. (Colorado Univ., Boulder (USA)). 1976. Contract EY-76-S-02-2557. 28p. Dep. NTIS $4.00.

Results of a preliminary study of the use of a model potential approach to the calculation of energy levels and radiative transition probabilities for highly ionized heavy atoms are reported. The calculations were carried out for eight ions in the sodium isoelectronic sequence from Mg II through W LXIV. The technique used involved the solution of the Dirac equation for the single outer valence electron, with a model central potential containing two disposable parameters affecting the potential in the region of the atomic core. The effect of core polarization was incorporated in the model potential. The parameters in the model potential were chosen by an initial solution of the nonrelativistic Schroedinger equation for the single outer valence electron, with the requirement that calculated ionization energies reproduce the results of the best available nonrelativistic calculations. Comparison of results for nonrelativistic radiative transition probabilities provides the first check on the technique. Solutions of the Dirac equation are then compared with the results of other relativistic calculations and experimental measurements. The results, for both energy levels and radiative transition probabilities, are encouraging, and suggest that the wave functions obtained will be quite satisfactory for subsequent calculations of electron impact excitation of these ions.

25507 (LA—6554-MS) **Diagonal F/sup (4)/ and F/sup (6)/ for spherical-top molecules in angular-momentum states up to J = 100.** Krohn, B.J. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1976. Contract W-7405-ENG-36. 120p. Dep. NTIS $5.50.

Diagonal F/sup (4)/ and F/sup (6)/ coefficients of Moret-Bailly are presented for 2 less than or equal to J less than or equal to 100 along with multiples of these quantities that are convenient for fine-structure analysis in P -, Q -, and R - branches of fundamental-type bands in highly resolved infrared spectra of spherical-top molecules.

GENERAL FLUID DYNAMICS

REFER ALSO TO CITATION(S) 25555, 25716

25508 (SAND—76-8710) **Equilibrium and transport estimates for hydrogen and helium via Lennard—Jones fluid.** Ashurst, W.T. (Sandia Labs., Livermore, Calif. (USA)). Dec 1976. Contract E(29-1)-789. 306p. Dep. NTIS $9.75.

The results of molecular dynamic transport calculations for the Lennard—Jones shear viscosity and thermal conductivity over a wide density and temperature range have been succinctly expressed in terms of the excess coefficients (that part above the temperature-dependent dilute gas value). These expressions reproduce within 2 percent the experimental viscosity data of H_2 and D_2 (to 2000 atm); and within 5 percent the experimental thermal conductivity of H_2 (to 600 atm) and He (to 1200 atm). The Lennard—Jones equations-of-state, expressed as a density-temperature expansion for Helmholtz free energy, when combined with the hydrogen third virial coefficient reproduces hydrogen compressibility within 0.5 percent. These same expressions can also be used to estimate helium and hydrogen-helium compressibilities. FORTRAN program LJHEOS, which produces these estimates as a function of temperature and pressure (or density), has been used to generate tables of shear viscosity, thermal conductivity, compressibility (with quantum effects), density, internal energy, enthalpy, specific heats and their ratio, sound speed, kinematic viscosity, thermal diffusivity, Prandtl number, thermal expansion, Grashof number, entropy, and Helmholtz free energy for the hydrogen and helium isotopes. Twenty-eight isotherms (from -175°C to 3000°C) for pressure up to 20,000 atmospheres are given.

PROPERTIES AND STRUCTURE OF FLUIDS

REFER ALSO TO CITATION(S) 25581

SUPERFLUIDITY

REFER ALSO TO CITATION(S) 25598

HIGH ENERGY PHYSICS

25509 (LBL—5500) **Lectures on the new particles.** (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 18 Aug 1976. Contract W-7405-ENG-48. 114p. (CONF-760849—1). Dep. NTIS $5.50.

From Conference on particle physics; Stanford, California, United States of America (USA) (2 Aug 1976).

An attempt is made to discuss systematics of new particles and their spectroscopy in a simple manner. The main emphasis is on charm and SU(4), weak decays of charmed mesons, hadronic masses, and charmonium. (SDF)

25510 (RLO—2230-T4-151) **Annual report 1975.** Hwa, R.C. (Oregon Univ., Eugene (USA). Inst. of Theoretical Science). 26 Nov 1975. Contract E(45-1)-2230-TAS-4. 10p. Dep. NTIS $3.50.

A brief summary of research projects in theoretical high energy physics undertaken during 1975 is reported. Included is a list of papers published during the period. (SDF)

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

25511 (ANL-HEP-CP—76-52) **Heavy particle searches using main ring on doubler collisions.** Ayres, D.S.; Diebold, R. (Argonne National Lab., Ill. (USA)). 1 Sep 1976. Contract W-31-109-ENG-38. 23p. (CONF-760687—2). Dep. NTIS $3.50.

From Fermilab study of the doubler as collider; Aspen, Colorado, United States of America (USA) (28 Jun 1976).

A versatile, large angle spectrometer system is described which is capable of performing a variety of sensitive searches for new heavy particles which may emerge from the main ring on doubler collisions. Searches for long-lived heavy particles should be capable of reaching cross sections comparable to limits obtained in ISR experiments but would be sensitive to masses up to a factor of 10 larger. It seems likely that at least two high luminosity colinear intersections will be needed in order to perform the W-search and heavy particle search experiments early in the collider program. (SDF)

25512 (COO—1545-205) **High energy physics studies. Progress report, part I. Experimental program.** (Ohio State Univ., Columbus (USA)). 1976. Contract EY-76-C-02-1545. 27p. Dep. NTIS $4.00.

Experimental and theoretical research in high energy physics is summarized. A list of publications is included. (JFP)

ELECTROMAGNETIC INTERACTIONS

25513 **Compton spectrum due to L-shell electrons.** Swamy, S.T.P.V.J. (Osmania Univ., Hyderabad, India). *Spectrosc. Lett.;* 9: No. 11, 833-838(1976).

The Compton spectrum due to L-shell electrons of thorium was measured by the coincidence technique, using 279 keV incident gamma photons. The influence of L-shell electron momenta on the distribution of the scattered photons was studied with reference to the Compton profile due to free electrons and compared with the exact and impulse hydrogenic theoretical models. Significant deviations are found between experimental and theoretical Compton spectra.

WEAK INTERACTIONS

25514 (COO—2232A-47) **Dimuon and trimuon production in high energy neutrino and antineutrino interactions.** Barish, B.C.; Bartlett, J.F.; Bodek, A. (California Inst. of Tech., Pasadena (USA); Fermi National Accelerator Lab., Batavia, Ill. (USA); Rockefeller Univ., New York (USA)). 1976. Contract EY-76-C-02-2232. 35p. (CONF-761045—4; CALT—68-567). Dep. NTIS $4.00.

From Division of particles and fields conference; Upton, New York, United States of America (USA) (6 Oct 1976).

A report is given on studies on dimuon production in the high energy neutrino and antineutrino induced events accrued during an experiment to measure normalized neutrino and antineutrino cross sections at incident energies between 30 and 220 GeV. The rates, energy dependence, and scaling are discussed. (JFP)

STRONG BARYON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 25519

25515 (COO—1545-196) **N-P charge exchange scattering at FERMILAB.** Barton, H.R. Jr.; Reay, N.W.; Reibel, K. (Ohio State Univ., Columbus (USA)). 1976. Contract EY-76-C-02-1545. 11p. Dep. NTIS $3.50.

The neutron-proton charge exchange differential cross section has been measured in the momentum interval 60 to 300 GeV/c, with four-momentum transfers squared 0.002 to 0.8 $(GeV/c)^2$. Independent of incident momentum, the data are characterized by a sharp forward peak of width 0.02 $(GeV/c)^2$, followed by a shoulder and gentler falloff at higher momentum transfers.

25516 (COO—1545-200) **Some features of n-p charge exchange scattering between 60 and 300 GeV/c.** Barton, H.R. Jr.; Reay, N.W.; Reibel, K. (Ohio State Univ., Columbus (USA)). 1976. Contract EY-76-C-02-1545. 12p. Dep. NTIS $3.50.

The dependence of the n-p charge exchange cross section on the four-momentum transfer squared and on the incident momentum is examined, and some comparisons with data from lower energies are given. Implications for the difference between n-p and p-p total cross sections are presented.

25517 (COO—2197-43) **Pion—nucleon interaction and mesonic atoms. Progress report, February 1, 1976—January 31, 1977.** Rebka, G.A. Jr.; Kunselman, R. (Wyoming Univ., Laramie (USA)). 1977. Contract EY-76-S-02-2197. 13p. Dep. NTIS $3.50.

During the year February 1, 1976 to January 31, 1977, the major activities under task A have been completion of all equipment and programs necessary for operating Experiment No. 99, measurement of the cross section for $\pi p + p$ yields $\pi p + \pi i + n$ near threshold, operation of Experiment No. 99, preliminary analysis of the data gathered, and preparation of a proposal for an exploratory measurement of πi and πp double charge exchange in the disintegration of ^{16}O, ^{40}Ca, and ^{208}Pb. The initial, rough analysis of all data in Experiment No. 99 should be completed by the end of the contract year and will yield a total cross section for pion production at 6 energies between 225 and 350 MeV with 10 percent accuracy. In addition, the doubly differential cross section will be far more detailed than has previously been available at these energies. During the year February 1, 1976 to January 31, 1977, research under Task B, Mesonic Atoms, has included collection and analysis of muonic atom data at LAMPF, feasibility studies for a further beam in the stopped muon channel at LAMPF, analysis of antiprotonic atom data collected at BNL, and collection of data on the antiproton-hydrogen system at BNL. A list of publications is included.

STRONG MESON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 25517

25518 (LBL—5522) **Measurement of the K⁻p yields anti K⁰n total cross section below 1 GeV/c.** Pollard, D.L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 24 Sep 1976. Contract W-7405-ENG-48. 143p. Dep. NTIS $6.00.

Thesis.

The total cross section for the reaction K⁻p yields anti K⁰n was measured between 500 and 1050 MeV/c in steps of 10 MeV/c. The experiment was performed at the Brookhaven AGS using a negative kaon beam focused onto a 41 cm long liquid hydrogen target. The target was surrounded by a box of scintillation counters which detected and vetoed all charged final states. The charged particle veto box was in turn surrounded by a box of lead-scintillator sandwich shower counters. These counters detected and vetoed all final states with photons or $\pi 0$ ws. The only reaction left unvetoed was K⁻p yields K/sub L/n, the cross section for which is just ½ the K⁻p yields K/sub L/n, cross section. It was necessary to make a number of corrections to the data to account for event losses and inefficient background rejection. The final results have a statistical accuracy of 1% which is an improvement of almost a factor of 10 over previously existing data. An important new feature can be seen in the cross section, a significant shoulder between 825 and 900 MeV/c. Preliminary results from a partial wave analysis including the new data indicate that the new cross sections will be an important constraint on future analyses.

25519 (ORO—2504-250) **Neutral strange particle production in πpp interactions at 100 GeV/c.** Price, H.L. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). Aug 1976. Contract EY-76-C-05-2504. 124p. Dep. NTIS $5.50.

Thesis.

Production mechanisms in the single- and double-particle inclusive interactions: πp p yields K/sup O//sub s/ + X, LAMBDA⁰ + X, K⁰/sub s/ + π/sup +-/ + X, and LAMBDA⁰ + π/sup +-/ + X were studied including cluster effects, resonance, and rapidity correlations. A search was made for K* and Σ* resonances by examining effective mass distributions. It is found that the production of strange particles is not dominated by low mass resonances. (JFP)

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

GENERAL

REFER ALSO TO CITATION(S) 25512

25520 (COO—1545-202) **Quantum effects of pseudoparticle size.** Hietarinta, J.; Palmer, W.F.; Pinsky, S.S. (Ohio State Univ., Columbus (USA). Dept. of Physics). 1976. Contract EY-76-C-02-1545. 7p. Dep. NTIS $3.50.

It is shown that the calculation of quantum effects associated with the classical four dimensional pseudoparticle can be carried to completion in the one loop, lowest order in source approximation, with size effects calculated exactly. The result is finite, and leaves symmetry breaking results intact. For the case of two flavors the theory reduces to a particularly simple form which suggests that the pseudoparticle acts as a source of zero mass bosons which in turn are made of fermion pairs.

25521 (RLO—2230-T4-153) **Calculating hadronic cross-sections in specific symmetry schemes: an application to the psi p total cross-section.** Aubrecht, G.; Dash, J.W.; Razmi, M.S.K.; Teper, M. (Oregon Univ., Eugene (USA). Inst. of Theoretical Science). 1976. Contract E(45-1)-2230-TAS-4. 32p. Dep. NTIS $4.00.

A model for calculating ratios of cross sections is constructed. The model is applied to SU(3) calculating /sup sigma//sup K/rho/ sigma/sub π rho/, and then to SU(4) in order to estimate the psi rho cross section. Results are obtained in both "pure" and broken SU(4). The energy dependence of sigma/sub psi rho/ and the slope of the psi rho differential cross section are qualitatively discussed. Kinematic effects arising from mass splittings and t/sub min/ effects are crucial.

25522 (RLO—2230-T4-156) **Speculation on a new kind of matter.** Deshpande, N.G. (Oregon Univ., Eugene (USA)). Dec 1975. Contract E(45-1)-2230-TAS-4. 6p. Dep. NTIS $3.50.

The possible existence of heavy stable charged leptons, a feature allowed by unified gauge models, will result in the formation of new matter. The properties of the new substances and possible ways of detection are briefly discussed.

ELECTROMAGNETIC INTERACTIONS

25523 (COO—1545-181) **Magnetic monopole solution in non-Abelian gauge theory.** Hietarinta, J.; Takasugi, E.; Tanaka, K. (Ohio State Univ., Columbus (USA). Dept. of Physics). 1976. Contract E(11-1)-1545. 16p. Dep. NTIS $3.50.

An approximate analytic solution of the equations of motion of the 't Hooft magnetic monopole model is proposed. Virial type global tests are carried out for the solution. Then, the monopole mass, energies of the vector field A/sub mu/sup a/, Higgs field phi/sup a/ and interaction are computed in closed form. The form factors of A/sub i/sup a/ and phi/sup a/ in a quantized version are also calculated.

25524 (COO—1545-201) **Production of charmed meson pairs in electron—positron annihilation.** Suzuki, M.; Wada, W.W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; Ohio State Univ., Columbus (USA). Dept. of Physics). 27 Aug 1976. Contract EY-76-C-02-1545. 22p. (LBL—5377). Dep. NTIS $3.50.

Production of charmed meson pairs of J/sup P/ = 0⁻ and 1⁻ is examined near the threshold. Production cross sections are parametrized by a quark model of a broken SU(8) symmetry. The charmed hadron production is dominated by $(0^-, 1^-)$ pairs, and D* anti D* production comes out to be much too small to reproduce the higher peak in the recoil mass spectrum against D⁰(anti D⁰) through reflection. A few experimental measurements are pointed out that will clarify the origin of the higher peak of the recoil mass spectrum.

25525 (ORO—3992-290) **Hadron electromagnetic mass differences.** Deshpande, N.; Dicus, D.; Johnson, K.; Teplitz, V. (Texas Univ., Austin (USA). Center for Particle Theory). Dec 1976. Contract EY-76-S-05-3992. 45p. Dep. NTIS $4.00.

Mass differences between members of isotopic spin multiplets of hadrons are calculated in the M.I.T. bag model. All low mass, SU(4) multiplets of spin 0, ½, 1, and ³/₂ particles are considered.

Both Coulomb and magnetic contributions to mass differences are evaluated without the assumption of SU(6) degenerate intermediate states. The mass difference between the "up" and the "down" quarks inside the bag is not (necessarily) taken to be a constant: a parameterization is proposed for it that works well for its contribution to known hadron electromagnetic mass differences. Based on the parametrization a class of sum rules is presented for charmed particle electromagnetic mass differences.

25526 (UCID—16854) **Implicit numerical method for Compton scattering energy exchange between electrons and non-Planckian radiation.** Winslow, A.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Jul 1975. Contract W-7405-ENG-48. 25p. Dep. NTIS $3.50.

The multi-frequency grey method is extended to include Compton scattering. In this way one arrives at an expression for the total Compton scattering energy exchange rate, which, for a Planckian radiation field, reduces to a well known formula. 15 references, 5 graphs. (JFP)

WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 25490

25527 (COO—1545-199) **Inclusive neutrino interactions in a six quark model.** Aubrecht, G.J. II.; Takasugi, E.; Tanaka, K. (Ohio State Univ., Columbus (USA). Dept. of Physics). 1976. Contract EY-76-C-02-1545. 23p. Dep. NTIS $3.50.

The effects of non-diagonal terms in the neutral current of an SU(2) x U(1) gauge six-quark model with slow rescaling are examined. The model reproduces the experimental charged current data with appropriate choice of heavy quark masses. The experimental neutral current data requires at least five quarks to explain it. In our context, the predictions for various heavy quark masses and quark mixings differ most for energies in the range 0 to 50 GeV. The various quantities are also calculated for proton and neutron targets.

25528 (ORO—3992-295) **Tests and predictions of scalar exchange models of weak interactions.** Dicus, D.A. (Texas Univ., Austin (USA). Center for Particle Theory). 1976. Contract E(40-1)-3992. 29p. Dep. NTIS $4.00.

Variations of the renormalizable spin-zero exchange model of weak interactions are discussed. The predictions of the various forms of the models are listed and compared with an eye toward separating the various forms from each other and from gauge theories. Previous predictions are updated by taking into account the improved measurement of the magnetic moment of the muon.

STRONG INTERACTIONS, GENERAL

25529 (LBL—5524) **Review of radiative transitions and decays of psi and psi'.** Chanowitz, M.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 6 Oct 1976. Contract W-7405-ENG-48. 27p. (CONF-760719—25). Dep. NTIS $4.00.

From 18. international conference on high energy physics; Tbilisi, Union of Soviet Socialist Republics (USSR) (15 Jul 1976).

Theoretical ideas about the new particle spectrum and dynamics are compared with the experimental data for the radiative transitions and decays of psi' and psi.

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

25530 (FERMILAB-CONF—76/67-EXP) **Coherent elastic and inelastic scattering from deuterium and helium.** Malamud, R. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). Jul 1976. Contract E(49-8)-3000. 13p. (CONF-760685—1). Dep. NTIS $3.50.

From Topical meeting on multiparticle production on nuclei at very high energy; Trieste, Italy (10 Jun 1976).

Some results of USA-Dubna experiments on coherent scattering of protons by protons and deuterons are reviewed. Reactions are either elastic scattering or are inclusive inelastic where the proton is diffractively dissociated. In addition, objectives of future experiments using the P-^{4}He system are briefly outlined. (SDF)

25531 (ORO—3992-294) **High energy hadron-nucleus collisions.** Bialkowski, G.; Chiu, C.B.; Tow, D.M. (Texas Univ., Austin (USA). Center for Particle Theory). Dec 1976. Contract E(40-1)-3992;NSF-GF-42060. 35p. Dep. NTIS $4.00.

A new space-time model for hadron-nucleus collisions is proposed, where produced particles at the instant of creation not only are immature, but their maturity rate is enhanced in the presence of other hadronic matter, as in a nucleus. The model's only free parameter, describing the maturity enhancement, is fixed by normalizing to the 200-GeV p-A multiplicity data at a fixed A. The parameter-free model then predicts correctly the p-A differential multiplicity as functions of the pseudo-rapidity eta and A, the multiplicity energy dependence, the π-A differential multiplicity, and the A-dependences of sigma/suppA//sub in/ and sigma /sup πA//sub in/. It is also shown quantitatively that the so-called "cut type model" and "fan-plus-cut type model" do not agree with the data.

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

APPLICATIONS TO STRONG INTERACTIONS

25532 (ORO—3992-286) **D^{0*} yields $D^0 l$ and other radiative decays of vector mesons.** Bohm, A.; Teese, R.B. (Texas Univ., Austin (USA). Center for Particle Theory). 1976. Contract E(40-1)-3992. 14p. Dep. NTIS $3.50.

Using SU(4) as a spectrum generating group the radiative decay rates of the charmed vector mesons and of J(psi) are calculated. With the known decay rates of the old mesons GAMMA(ω yields $\pi\gamma$), GAMMA(phi yields eta γ), GAMMA(rho yields $\pi\gamma$), GAMMA(K^{0*} yields $K^0 l$) as input one obtains GAMMA(K^{+*} yields $K^+ l$) = 2.6 keV, GAMMA(ω yields eta γ) = 220 eV, GAMMA(rho yields eta γ) = 4.8 keV, GAMMA(psi yields chi γ) = 1.6 keV, GAMMA(D^{0*} yields $D^0 l$) = 350 eV and GAMMA(D^{+*} yields $D^+ l$) = 22 eV.

FIELD THEORY

25533 (COO—1545-203) **Reduction of field equations and saturated bounds for vortex-line theories.** Hietarinta, J. (Ohio State Univ., Columbus (USA). Dept. of Physics). 1976. Contract EY-76-C-02-1545. 12p. Dep. NTIS $3.50.

The Euler-Lagrange equations following from the two-dimensional Higgs-type Lagrangian and from the chirally nonlinear Lagrangian are shown to be reducible to one second order differential equation. This simplification is possible for an arbitrary configuration of static parallel vortex-lines but only for a specific potential. In both cases the result is connected with a saturated bound for the energy and also with conditions arising from the scale variation.

25534 **Generalized local gauge symmetry and the Ward—Takahashi identities in unified field theories.** Hsu, J.P. (Univ. of Texas, Austin). *Found. Phys.;* 6: No. 6, 707-716(Dec 1976).

The symmetry basis of unified field theories, i.e., the generalized concept of local gauge symmetry, and its physical implications are discussed. The generalized Ward—Takahashi identities and the explicit constraints among renormalization constants are derived by using the path integral in a specific model. These constraints are confirmed at the one-loop level.

NUCLEAR PHYSICS

25535 (COO—535-763) **Nuclear Physics Laboratory, University of Colorado technical progress report, 1976 and proposal for continuation of contract.** (Colorado Univ., Boulder (USA). Nuclear Physics Lab.). 1 Nov 1976. Contract EY-76-C-02-0535. 162p. Dep. NTIS $6.75.

This report summarizes the work carried out at the Nuclear Physics Laboratory of the University of Colorado during the period November 1, 1975 to November 1, 1976. The low energy nuclear physics section is dominated by light-ion reaction studies which span a wide range. These include both two-neutron and two-proton transfer reactions, charge exchange and inelastic scattering, as well as single nucleon transfer reactions. The nuclei studied vary widely in their mass and characteristics. These reaction studies have been aided by the multi-use scattering chamber which now allows the energy-loss-spectrometer beam preparation system (beam swinger) to shift from charged particle studies to neutron time-of-flight studies with a minimum loss of time. The intermediate energy section reflects the increase in activity accompanying the arrival of LAMPF data and the initiation of (p,d) studies at the Indiana separated-sector cyclotron. The nucleon removal results provided by the π beam at EPICS previous to completion of the spectrometer have shown that nuclear effects dominate this process, so that the widely used free interaction picture is inadequate. The section entitled "Other Activities" reveals continuing activities in new applications of nuclear techniques to problems in medicine and biology. Reactions important to astrophysics continue to be investigated and our trace-element program remains at a high level of activity. The theoretical section reports new progress in understanding magnitudes of two-step reactions by inclusion of finite-range effects. A new finite-range program which is fast and economical has been completed. Intermediate energy results include calculations of π-γ angular correlations, low energy π-nucleus interactions, as well as (p,d) and nucleon scattering calculations for intermediate energies.

25536 (COO—1265-183) **John H. Williams Laboratory of Nuclear Physics, University of Minnesota annual report, 1976.** (Minnesota Univ., Minneapolis (USA). John H. Williams Lab. of Nuclear Physics). Jan 1977. Contract EY-76-C-02-1265. 132p. Dep. NTIS $6.00.

This report summarizes the work done at the Williams Laboratory of the University of Minnesota during the period from August 1975 through 1976. The major part of this report describes recent results and work in progress in the nuclear physics research program. Work involving beams of light ions and light element targets is followed by work using heavier targets and then the experiments using beams of oxygen and fluorine ions. This heavy ion work occupies a larger portion of our program than in previous reports. The investigation of L-subshell ionization cross sections for heavy element targets and the studies of hyperfine splitting and isotope shifts are briefly described. The improved operation of the tandem Van de Graaff resulting from the installation of a new set of acceleration tubes and other modifications is discussed. The current state of the testing of an on-line mass spectrometer and the installation of a source producing a beam of tritons is described. The final sections of this report list personnel, degrees granted, and publications of the staff. Separate indexing has been prepared for 10 sections of this report for appearance in ERA.

25537 (LA—6560-PR) **Applied nuclear data research and development. Quarterly progress report, April 1—June 30, 1976.** Baxman, C.I.; Young, P.G. (comps.). (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 67p. Dep. NTIS $4.50.

This progress report describes the activities of the Los Alamos Nuclear Data Group for the period April 1 through June 30, 1976. The topical content is summarized in the contents.

25538 (TID—27236) **Research in neutron velocity spectroscopy. Final report.** Rainwater, J. (Columbia Univ., Irvington-on-Hudson, N.Y. (USA). Nevis Labs.). 1976. Contract EY-76-C-02-2174. 7p. Dep. NTIS $3.50.

A brief summary of papers published since the last progress report (June 1974) is presented. The research represents contributions to neutron resonance spectroscopy below 100 keV. (SDF)

EXPERIMENTAL TECHNIQUES

25539 (ANL—76-90, pp 421-430) **Requirements on experiment reporting to meet evaluation needs.** Peelle, R.W. (Oak Ridge National Lab., TN). 1976.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

In Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-238, and Pu-239.

To define the requirements placed by the evaluation of nuclear cross sections upon the reporting of experimental results, a model of part of the evaluation process is presented. The model is a straightforward application of nondiagonal weighted least-squares estimation to average cross sections in the energy regions where the shape of the cross section is not given by theory. To combine in a logical way the existing evaluated information with one or more new sets of experimental results, the estimated covariance matrix of each experimenter's results needs to be known on an appropriate mesh. The likelihood that each experimenter may underestimate the uncertainties in his results does not remove the need for him to record for users the estimated magnitudes and correlation patterns of these uncertainties.

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

25540 (LA—6518-MS) **Light element standard cross sections for ENDF/B. Version IV.** Hale, G.M.; Stewart, L.; Young, P.G. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1976. Contract W-7405-ENG-36. 37p. Dep. NTIS $4.00.

Several light-element standard cross-section evaluations in the ENDF/B-IV file are described and compared with experimental measurements. The hydrogen scattering cross section has long been accepted as a standard since it is essentially equal to the total cross section which is well known and varies smoothly with incident neutron energy. The ^{3}He(n,p)T, ^{6}Li(n,t)α, ^{10}B(n,αX)^{7}Li, and ^{10}B(n,$\alpha\gamma$)^{7}Li*(478-keV γ) reactions have positive Q values and large thermal cross sections which make them ideal to use in neutron flux monitors. The Yale phase shifts were used to generate the hydrogen elastic scattering cross section and angular distributions while comprehensive R-matrix analyses were performed to determine the ^{6}Li and ^{10}B cross sections.

25541 (LA—6561-T) **Measurements of pion-helium total cross sections at energies from 51 to 105 MeV.** Johnson, K.F. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1976. Contract W-7405-ENG-36. 223p. Dep. NTIS $7.75.

Thesis.

Measurements of πip-^{4}He total cross sections have been made at energies from 51 to 105 MeV using a superfluid ^{4}He target at the Low Energy Pion channel of the LAMPF accelerator in Los Alamos. Pions were selected with either a DISC counter or a time-of-flight system. The scattered pions were detected by a series of circular plastic scintillation counters using standard transmission techniques. The resulting partial removal cross sections were extrapolated to zero solid angle after being corrected for Coulomb effects, pion decay, accidental counts, counter absorption and efficiencies, and statistical correlations. The resulting statistical errors were generally approximately 3-5 percent. The measured total cross sections were found to be in good statistical agreement with previous measurements and in poor agreement with the predictions of several optical potentials in current use. Through an optical theorem the imaginary part of the forward scattering amplitude was found. The total cross sections have been used with previously-measured angular distributions through a phenomenological model to obtain the real part of the forward scattering amplitude at four energies between 50 and 75 MeV. These results were found to be in good agreement with forward dispersion relation calculations.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL

ENERGY LEVELS AND TRANSITIONS

25542 (BNL—21829) **SU3 shell model calculations for light nuclei.** Millener, D.J. (Brookhaven National Lab., Upton, N.Y. (USA)). Aug 1976. Contract E(30-1)-16. 23p. (CONF-760991—1). Dep. NTIS $3.50.

From Nuclear theory conference; Kingston, Canada (3 Sep 1976).

Shell model calculations in the supermultiplet SU-4/SU-3 basis are illustrated for several major shells of ^{16}O. The classification scheme and its connection with the effective interaction are briefly discussed. (SDF)

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 25546

25543 (COO—1265-183, pp 17-30) **Influence of the Pauli principle on the optical potential for α + ^{16}O scattering.** Brown, R.E.; Partridge, R.A.; Tang, Y.C.; Thompson, D.R. Jan 1977.

In John H. Williams Laboratory of Nuclear Physics, University of Minnesota annual report, 1976.

The problem of alpha + ^{16}O scattering has been studied using a model in which the effective intercluster potential contains a Pauli repulsive core and has an odd-even dependence on the orbital angular momentum. The analysis reproduces essential features of the scattering problem and yields the feature of large back-angle enhancement. (SDF)

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

MOMENTS AND SPIN

25544 (COO—1265-183, pp 94-98) **Quadrupole moment of ^{18}O (1.98 MeV, 2^{+}).** Dehnhard, D.; Artz, J.L.; Weber, D.J.; Falkenberg, R.J.; Li, T.K.; Kubono, S. Jan 1977.

In John H. Williams Laboratory of Nuclear Physics, University of Minnesota annual report, 1976.

The quadrupole moment of the first excited state of ^{18}O was measured via the ^{208}Pb(^{18}O, ^{18}O) reaction at 63 MeV. Results are a factor of 2 larger than theory. (SDF)

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 25540

25545 (COO—1265-183, pp 55-60) **^{18}O(^{18}O,^{16}O)^{20}O reaction at 52 MeV.** Kubono, S.; Li, T.K.; Dehnhard, D.; Petersen, J.F.; Lewis, D.A.; Artz, J.L.; Bayman, B.F. Jan 1977.

In John H. Williams Laboratory of Nuclear Physics, University of Minnesota annual report, 1976.

Differential cross sections are given for the reaction ^{18}O(^{18}O, ^{16}O)^{20}O and for elastic scattering of ^{18}O on ^{18}O at 52 MeV. (SDF)

25546 (ORO—5128-5) **Study of the (p,d^{3}He) reaction as a quasi-free reaction process.** Cowley, A.A.; Roos, P.G.; Chant, N.S.;

Woody, R. III; Holmgren, H.D.; Goldberg, D.A. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). Nov 1976. Contract EY-76-S-05-5128. 34p. Dep. NTIS $4.00.

The (p,d^{3}He) reaction on ^{6}Li, ^{7}Li, ^{9}Be, and ^{12}C has been investigated in conjunction with studies of the (p,pα) reaction on the same targets. Coincident data for all four targets were obtained at a bombarding energy of 100 MeV for numerous angle pairs in order to test the reaction mechanism. Comparisons of the (p,d^{3}He) data to both (p,pα) data and distorted wave impulse approximation calculations (DWIA) indicate a dominance of the direct quasi-free reaction process (p + alpha yields d + ^{3}He). The absolute alpha-particle spectroscopic factors extracted using DWIA analysis are in agreement with the values obtained in the (p,pα) reaction.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

25547 (COO—1265-183, pp 61-67) **Elastic scattering of ^{16}O on ^{28}Si, ^{29}Si, and ^{30}Si at 60 MeV.** Shkolnik, V.; Dehnhard, D.; Artz, J.L.; Weber, D.J.; Franey, M.A. Jan 1977.

In John H. Williams Laboratory of Nuclear Physics, University of Minnesota annual report, 1976.

Cross sections for the elastic scattering of ^{16}O on ^{28}Si at 60 MeV are reported. The data show a well defined oscillatory structure superimposed on a smooth Rutherford background. (SDF)

25548 (COO—1265-183, pp 68-84) **^{28}Si(^{19}F,^{16}O)^{31}P three-nucleon transfer reaction.** Kubono, S.; Lewis, D.A.; Li, T.K.; Artz, J.L.; Petersen, J.F.; Dehnhard, D.; Weber, D.J. Jan 1977.

In John H. Williams Laboratory of Nuclear Physics, University of Minnesota annual report, 1976.

Angular distributions are given for the ^{28}Si(^{19}F, ^{16}O)^{31}P reaction to the ½i ground state and to the ⅜i and ⅝i states at 1.27 and 2.23 MeV. The elastic scattering of ^{19}F on ^{28}Si is also reported. Incident lab energy is 60 MeV. (SDF)

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

REFER ALSO TO CITATION(S) 25120

RADIOACTIVE DECAY

25549 (ORNL/NUREG—11) **Decay of ^{99}Mo.** Dickens, J.K.; Love, T.A. (Oak Ridge National Lab., Tenn. (USA)). 14 Dec 1976. Contract W-7405-ENG-26;NRC-INA-40-551-75;NRC-INA-40-552-75. 21p. Dep. NTIS $4.00.

Relative intensities for K x-rays and gamma rays emanating from ^{99}Mo in equilibrium with its ^{99}Tc* daughter have been measured using several Ge photon detectors. Combining these intensities with an evaluated set of electron-conversion coefficients has provided a set of absolute intensities for the observed gamma rays. The absolute intensity for the dominant 140.5-keV gamma ray in ^{99}Tc was determined to be 90.7 +- 0.6/100 ^{99}Mo disintegrations for ^{99}Mo decay in equilibrium with decay of the ^{99}Tc* daughter.

NUCLEAR REACTIONS AND SCATTERING

25550 (COO—1265-183, pp 31-38) **Population by the (p,n) reaction and decay by proton emission of isobaric analog states of ^{119}Sn.** Fitzgerald, D.H.; Greenlees, G.W.; Lilley, J.S.; Poppe, C.H. Jan 1977.

In John H. Williams Laboratory of Nuclear Physics, University of Minnesota annual report, 1976.

The reaction ^{119}Sn(p,n)^{119}Sb(IAS) yields p + ^{118}Sn was measured between 16 and 20 MeV using neutron time-of-flight in coincidence with the p decay. Differential cross sections and angular distributions are shown. (SDF)

25551 (COO—1265-183, pp 85-93) **Elastic and inelastic scattering of ^{16}O by $^{148\ 150\ 152\ 154}$Sm in the coulomb-nuclear interference region.** Weber, D.; Shkolnik, V.; Artz, J.; Dehnhard, D.; Hintz, N. Jan 1977.

In John H. Williams Laboratory of Nuclear Physics, University of Minnesota annual report, 1976.

Angular distributions are obtained for elastic and inelastic scattering of ^{16}O from $^{148\ 150\ 152}$Sm at 40 MeV, from ^{152}Sm at 59 MeV and from $^{148\ 152}$Sm at 72 MeV. Excitation functions were measured on elastic and inelastic scattering from 20 to 67 MeV for ^{152}Sm, 20 to 68 MeV for $^{148\ 150}$Sm, and 30 to 60 MeV for ^{154}Sm. Analysis of data is incomplete. (SDF)

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 25120

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 25551

25552 (COO—1265-183, pp 39-54) **Study of $^{190\ 192\ 194}$Pt using the (p,t) reaction.** Vergnes, M.; Rotbard, G.; Kalifa, J.; Vernotte, J.; Berrier, G.; Seltz, R.; Sharma, H.L.; Hintz, N. Jan 1977.

In John H. Williams Laboratory of Nuclear Physics, University of Minnesota annual report, 1976.

Angular distributions and relative intensities for a few O^+ states are shown for the reactions $^{190\ 192\ 194}$P/sub t/(p,t) at 26 MeV incident proton energy. (SDF)

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 25120

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL

RADIOACTIVE DECAY

25553 (LBL—4460) **Decay studies of a long lived high spin isomer of ^{210}Bi.** Tuggle, D.G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1976. Contract W-7405-ENG-48. 126p. Dep. NTIS $6.00.

Thesis.

A source of approximately 30 μg of pure (< 90%) /sup 210m/Bi ($J\pi$ = 9-) was prepared by irradiating ^{209}Bi in a nuclear reactor. After chemical separations to remove ^{210}Po from the irradiated bismuth sample were completed, the ^{210}Bi was electromagnetically separated from the ^{209}Bi by a series of two isotope separations to create the source mentioned above. This source was then used to conduct alpha, conversion electron, gamma, gamma-gamma coincidence, and alpha-gamma coincidence spectroscopic studies of the decay of /sup 210m/Bi. The partial half life for the alpha decay of /sup 210m/Bi was measured as 3.0 x 10^6 yr. A lower limit of 10^{13} years was set for the partial half life for the decay of /sup 210m/Bi to ^{210}Po. Alpha decay of /sup 210m/Bi to 8 excited states of ^{206}Tl was observed. A lower limit of 10^{-4}% was set for the branching ratio of the parity forbidden alpha decay of ^{210}Bi to the ^{206}Ti ground state. Theoretical decay rates for the alpha decays of /sup 210m/Bi, ^{210}Bi, ^{211}Po, and /sup 211m/Po were calculated using the method developed by Hans Mang. A comparison of the calculated and experimentally measured alpha decay rates of /sup 210m/Bi showed good agreement for the relative alpha decay rates.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 25553

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 25556

25554 (UCID—17337) **Neutron and fission yields from high-energy deuterons in infinite ^{238}U targets.** Canfield, E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Jun 1965. Contract W-7405-ENG-48. 12p. Dep. NTIS $3.50.

Early work on the interaction of high energy deuterons with large ^{238}U targets is reexamined and current theoretical study is discussed. Results of fission and neutron yield calculations are compared with experiment. (SDF)

25555 Relativistic fluid dynamics calculations with the particle-in-cell technique. Harlow, F.H.; Amsden, A.A.; Nix, J.R. (Los Alamos Scientific Lab., NM). *J. Comput. Phys.;* **20**: No. 2, 119-129(Feb 1976).

A technique is described for solving numerically the fully relativistic equations of fluid dynamics, for time-varying flows in two and three space dimensions. Based on the particle-in-cell technique, this extension has been developed especially for the investigation of high-energy collisions between atomic nuclei. Results are shown of a calculation in which an oxygen nucleus (^{16}O) impacts onto a uranium nucleus (^{238}U) at a speed that is 0.9516 times the vacuum speed of light.

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 25554

25556 (ANL—76-90, pp 382-390) **Simulation of the structure in ^{235}U cross sections.** James, G.D. (Atomic Energy Research Establishment, Harwell, Eng.). 1976.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

In Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-238, and Pu-239.

The significant structure which has been shown to exist in the neutron induced fission and capture cross sections of ^{235}U over the energy range 10 keV to 40 keV has been accurately reproduced by a simulation process which enables the energy dependence of the average fission width to be deduced.

25557 (ANL—76-90, pp 391-397) **Energy gap at the saddle point deformation of ^{236}U.** Kaeppeler, F.; Dickmann, F. (Kernforschungszentrum, Karlsruhe, Ger.). 1976.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

In Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-238, and Pu-239.

A steep increase in the fission cross section of ^{235}U at .95 MeV neutron energy was interpreted as due to the onset of quasi particle excitations in ^{236}U. Together with the result of a recent evaluation of the ^{236}U fission barrier an improved value of the energy gap at the saddle point deformation 2Δ/sub s/ = 1.79 +- 0.2 MeV was determined. This value is discussed with respect to current assumptions on the deformation dependence of the pairing force parameter G.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

25558 (LBL—5081) **Central collisions of relativistic heavy ions.** Gutbrod, H.H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1976. Contract W-7405-ENG-48. 7p. (CONF-760943—1). Dep. NTIS $3.50.

From Conference on nuclear physics with heavy ions; Caen, France (6 Sep 1976).

Double differential cross sections have been measured for high energy p,d,t, ^{3}He, and ^{4}He particles emitted from uranium targets irradiated with ^{20}Ne ions at 250, 400, and 2100 MeV/nucleon and ^{4}He ions at 400 MeV/nucleon. By using the shape and yield of the proton energy spectra, the shape and yield of the d, t, ^{3}He, and ^{4}He energy spectra can be deduced at all measured angles for all incident projectile energies assuming that they are formed by coalescence of cascade nucleons. Finally, it is found that the overall features of the proton inclusive spectra are fit without any adjustable parameter by a proposed nuclear fireball model. In this model the nucleons which are mutually swept out from the target and projectile form a hot quasi-equilibrated fireball which decays as an ideal gas.

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 24753

25559 (ANL—76-90) **Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239, Argonne, Illinois, June 28—30, 1976.** Poenitz, W.P.; Smith, A.B. (eds.). (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 472p. (CONF-760647—; ERDA-NDC—5/L; NEANDC(US)—199/L). Dep. NTIS $12.00.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

Abstracts for 21 papers appear separately in ERA. For abstracts of the remaining papers, refer to CONF-760647- in the ERA cumulative report number index. (SDF)

25560 (ANL—76-90, pp 31-44) **Importance of fast fission cross sections in fast reactors.** Bohn, E.M.; McKnight, R.D. (Argonne National Lab., IL). 1976.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

In Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-238, and Pu-239.

In most cases requirements on the accuracy of the important fast fission cross sections for fast reactors have not yet been attained. The adequacy of fast fission cross section evaluations are most conveniently tested by computing integral measurements in benchmark fast critical assemblies. Results of sensitivity analyses of the U and Pu fission cross sections for two large benchmark fast critical assemblies (ZPR6-A and ZPR6-7) are presented herein. These sensitivity coefficients emphasize the importance of fast fission cross sections in fast reactor design and, along with the benchmark tests, point out the continued need for improvement in the evaluation of fast fission data.

25561 (ANL—76-90, pp 73-93) **Fission cross sections of uranium and plutonium isotopes relative to U-235.** Meadows, J.W. (Argonne National Lab., IL). 1976.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

In Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-238, and Pu-239.

The cross sections of U-233, U-234, U-238, Pu-239 and Pu-242 have been measured relative to U-235 using the ANL FNG facility. All measurements were within the energy range 0.1-10 MeV. Sample mass ratios were based on the alpha decay ratio, the thermal fission ratio, and the mass analysis of specially prepared isotopes mixtures.

25562 (ANL—76-90, pp 94-113) **Measurements of neutron induced fission cross section ratios at the Karlsruhe Isochronous Cyclotron.** Cierjacks, S.; Leugers, B.; Kari, K.; Brotz, B.; Erbe, D.; Groeschel, D.; Schmalz, G.; Voss, F. (Kernforschungszentrum, Karlsruhe, Ger.). 1976.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

In Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-238, and Pu-239.

Ratios of the fission cross sections of ^{238}U and ^{239}Pu relative to ^{235}U were measured with the fast neutron time-of-flight facility at the Karlsruhe isochronous cyclotron. With the continuous energy neutron source the entire range from 0.5 - 30 MeV was covered in one experiment. In the experiments gas scintillation counting of the fission fragments and coincidence techniques were employed. Typical energy resolutions range between 0.7 percent at 0.5 MeV and 3 percent at 30 MeV. For the ^{238}U/^{235}U ratio most of the data have counting statistics smaller than 3 percent, for the ^{239}Pu/^{236}PU counting statistics does not exceed 2 percent.

25563 (ANL—76-90, pp 128-140) **Fission cross section ratio measurement of ^{238}U to ^{235}U for neutrons with energies between 4.7 and 8.9 MeV.** Nordborg, C. (Tandem Accelerator Lab., Uppsala); Conde, H.; Stroemberg, L.G. 1976.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

In Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-238, and Pu-239.

The ratio between the fission cross section for ^{238}U and ^{235}U has been measured with a back-to-back fission chamber for incident neutrons between 4.7 and 8.9 MeV. The obtained data is in fair agreement with those of other recent experiments although the overall spread of data points from these experiments is very large.

25564 (ANL—76-90, pp 141-148) **Measurements of ^{238}U/^{235}U fission cross section ratios in the energy range 27 MeV.** Cance, M.; Grenier, G. (Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France). 1976.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

In Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-238, and Pu-239.

Measurements of ^{238}U/^{235}U fission cross section ratios have been made with a double 4π ionization chamber in the energy range 2-7 MeV. A pulsed 4 MeV Van de Graaff accelerator was used with T(p,n)^{3}He and D(d,n)^{3} reactions as neutron sources. The final values of ^{238}U/^{235}U fission cross section ratios are given with 3 percent uncertainty.

25565 (ANL—76-90, pp 149-153) **^{238}U/^{235}U fission cross section ratio over the energy range 1.2 MeV to 2 MeV.** Evans, P.A.R.; Huxtable, G.B.; James, G.D. (Atomic Energy Research Establishment, Harwell, Eng.). 1976.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

In Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-238, and Pu-239.

The $^{238}U/^{235}U$ fission cross section ratio over the energy range 1.2 MeV to 2 MeV has been determined mainly to establish an accurate energy for the ^{238}U fission cross section threshold.

25566 (ANL—76-90, pp 154-169) **Comments on the evaluation of fission cross section ratios for U-238 and Pu-239 to U-235.** Poenitz, W.P.; Guenther, P. (Argonne National Lab., IL). 1976.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

In Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-238, and Pu-239.

First approximation evaluated fission cross section ratios for U-238/U-235 and Pu-239/U-235 were obtained. The absolute normalization of the U-238/U-235 ratio appears to be established with a 1 percent uncertainty at the 99 percent confidence level. Available data for the Pu-239/U-235 ratio are insufficient to obtain a similar low uncertainty level.

25567 (ANL—76-90, pp 173-182) **Fission cross section of ^{235}U from 1 to 6 MeV.** Barton, D.M.; Diven, B.C.; Hansen, G.E.; Jarvis, G.A.; Koontz, P.G.; Smith, R.K. (Los Alamos Scientific Lab., NM). 1976.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

In Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-238, and Pu-239.

The ratio of the neutron-induced fission cross section of ^{235}U to the neutron-proton scattering cross section was measured in the neutron energy region from 1 to 6 MeV. The neutron source was the T(p,n) reaction produced by a pulsed Van de Graaff proton beam on a thin tritium gas target. The use of monoenergetic neutrons allowed time-of-flight methods to be used to study carefully backgrounds and source characteristics.

25568 (ANL—76-90, pp 183-207) **^{235}U neutron fission cross section measurement at the NBS linac.** Wasson, O.A. (National Bureau of Standards, Washington, DC). 1976.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

In Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-238, and Pu-239.

The ^{235}U neutron fission cross section was measured relative to neutron-proton scattering from 5 to 800 keV neutron energy. The experiment was performed on the 200 m flight path at the NBS electron linac using a hydrogen gas proportional counter as a neutron flux monitor. This relative measurement was normalized by means of a second experiment on the 23 m flight path. This experiment, which used a 0.5 mm ^{6}Li glass for a flux monitor, covered the energy region from 6 eV to 30 keV, and, normalized to an integrated cross section of 238.4 eV b in the 7.8 to 11.0 eV region, yields an average cross section of 2.48 +- 0.05 b for the 10 to 20 keV interval. The resultant cross section in the 200-800 keV interval is approximately 5 percent less than the ENDF/B-IV evaluation.

25569 (ANL—76-90, pp 208-224) **Measurement of the neutron induced fission cross sections of uranium 235 and plutonium 239 in the MeV energy range.** Szabo, I. (CEN, Saint-Paul-lez-Durance, France); Marquette, J.P.; Derrien, H. 1976.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

In Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-238, and Pu-239.

The fission cross sections of U-235 and Pu-239 were measured for incident neutron energies between 2.3 and 5.5 MeV. The neutron flux was measured by means of a calibrated directional counter and the fission events were detected in thin-walled ionization chambers. Time-of-flight technique was used in order to determine both the scattered neutrons and parasitic sources of neutrons. For incident neutron energies lower than 2.5 MeV, a good agreement is observed with results from other measurements. For higher energies, the results of the present measurement when compared with the most recent data, are about 6 percent lower. However, they agree well with results from older sources. Final, revised values of all of our previous measurements are also reported. The definitive set of data covers the energy range from 0.01 to 5.5 MeV.

25570 (ANL—76-90, pp 225-236) **Absolute measurements of ^{235}U and ^{239}Pu fission cross sections with photoneutron sources.** Davis, M.C.; Knoll, G.F.; Robertson, J.C. (Univ. of Michigan, Ann Arbor). 1976.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

In Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-238, and Pu-239.

The fission cross sections of ^{235}U and ^{239}Pu for Na-Be, La-Be, Na-D, and Ga-D photoneutrons have been measured absolutely (i.e., without significant dependence on other cross section data). The neutron flux at the targets was calculated from the experimental geometry and by using a manganese bath to compare the photoneutron source yield with the standard source NBS-II. Fission counts were accumulated with the source positioned symmetrically between two identical foils and detectors in an experiment package suspended in a low-albedo laboratory. Fission fragments passing through limited solid angle apertures were recorded on polyester track-etch films. The masses of the foil deposits were determined by microbalance weighings and confirmed by thermal fission and alpha counting. After making a correction for the calculated energy distribution of the source neutrons, values of 1.471, 1.271, 1.161, and 1.210 barns were obtained for the ^{235}U fission cross section at neutrons energies of 140, 265, 770, and 964 keV, respectively. Corresponding values of 1.465, 1.490, 1.678, and 1.644 barns were derived for ^{239}Pu. Present uncertainties are about 2.0 percent for the ^{235}U values and 2.5 percent for the ^{239}Pu results.

25571 (ANL—76-90, pp 237-245) **Absolute measurement of 14.6 MeV neutron fission cross sections of ^{235}U and ^{238}U.** Cance, M.; Grenier, G. (Service de Physique Nucleaire Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France). 1976.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

In Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-238, and Pu-239.

Absolute measurements of 14.6 MeV fission cross sections of ^{235}U and ^{238}U have been made with a double 4π ionization chamber. The associated particle method was used. The final values of sigma/sub nf/(^{235}U), sigma/sub nf/(^{238}U) and sigma/sub nf/(^{238}U)sigma/sub nf/(^{235}U) are given with 1.9, 2.2 and 3 percent uncertainty, respectively.

25572 (ANL—76-90, pp 246-257) **^{235}U and ^{238}U neutron induced fission cross sections relative to the H(n,p) cross section.** Leugers, B.; Cierjacks, S.; Brontz, P.; Erbe, D.; Groeschel, D.; Schmalz, G.; Voss, F. (Kernforschungszentrum, Karlsruhe, Ger.). 1976.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

In Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-238, and Pu-239.

The fission cross sections of ^{235}U and ^{238}U have been measured with the fast neutron time-of-flight facility at the Karlsruhe Isochronous Cyclotron in the range from 1-20 MeV. Fission events were detected with gas scintillation counters requiring coincidences from both fission fragments. The fast neutron flux was measured with a telescope-like proton recoil detector. The transmission flux detector allowed a simultaneous measurement of the neutrons at the fission foil position. The fission cross sections have counting uncertainties of less than approximately 3 percent for most of the ^{235}U-data points and of less than approximately 4 percent for most of the ^{238}U-data points.

25573 (ANL—76-90, pp 270-277) **Structure limitation on accuracy of ^{238}U fission cross section measurements.** Bowman, C.D.; Lamaze, G.P.; Duvall, K.C.; Schrack, R.A. (National Bureau of Standards, Washington, DC). 1976.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

In Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-238, and Pu-239.

High resolution measurements of the ^{238}U fission cross section carried out at LLL in 1970 have been averaged using Gaussian averaging functions with a FWHM = 1 percent, 2.5 percent, 5 percent, and 10 percent. Deviations from the 10 percent average are calculated and the results expressed in a table which permits an estimate of uncertainties introduced by the cross section fine structure for monoenergetic measurements of known resolution.

25574 (ANL—76-90, pp 281-306) **Common normalization of several ^{235}U fission data sets in the thermal and resonance region.** Leonard, B.R. Jr. (Battelle-Northwest, Richland, WA). 1976.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

In Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-238, and Pu-239.

An evaluation of the cross sections of ^{235}U below 1 eV was recently completed at Battelle-Northwest (BNW). In this evaluation, energy-dependent data of all of the partial cross sections, their ratios and total were simultaneously fitted by a nonlinear least-squares fitting code, SIGLEARN, to a modified Adler-Adler multilevel resonance fission and multilevel Breit-Wigner scattering formalism. The data of eight relative fission cross section measurements were compared to the evaluated shape using SIGLEARN to establish best-estimate normalization values at 2200 m/s and their uncertainties on a consistent basis. The indicated uncertainties of these shape-fitted normalizations due to uncertainties in: the evaluated shape, deviations from the evaluated shape, data precisions, energy region used in the normalization, internal data discrepancies and other unknown factors were less than one percent for six of the experiments. The most significant problem appeared in the thermal normalization of the data of Deruytter and Wagemans where the possible normalization values differed by over two percent. Values of the integral fission cross section from 7.8- to 11-eV were then calculated by a consistent method for each data set renormalized to sigma^{0}/sub f/ = 583.54 b, the value proposed for version V of ENDF/B. The resultant values of the fission integrals were then evaluated by a working group to obtain a best-estimate value to which fission data sets, which do not go down below 1 eV, could be normalized. The value obtained was 241.24 b.eV but an uncertainty of nearly three percent is required to reasonably cover the spread of the values.

25575 (ANL—76-90, pp 333-352) **Fission cross sections of ^{235}U, ^{238}U, and ^{239}Pu averaged over the ^{252}Cf neutron spectrum.** Heaton, H.T. II; Gilliam, D.M.; Spiegel, V.; Eisenhauer, C. Grundl, J.A. (National Bureau of Standards, Washington, DC). 1976.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

In Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-238, and Pu-239.

A measurement was made in a ^{252}Cf spontaneous fission neutron field to determine the absolute fission cross section of ^{235}U (1205 +- 27 mb), and at the same time to determine the fission cross section ratio of $^{238}U/^{235}U$ (0.2644 +- 0.0035) and $^{239}Pu/^{235}U$ (1.500 +- 0.024). Two NBS double fission chambers were mounted 5 cm on either side of a singly encapsulated ^{252}Cf source (4 x 10^{9} n/sec, 1.4 mm^{3} emission volume) in compensated beam geometry. The Cf neutron source strength was calibrated in a Manganous Sulfate Bath relative to the NBS-I, the internationally compared Ra-Be photoneutron source. Corrections were made for geometrical effects (1.0085 +- 0.0064), for undetected fission fragments (typically 1.0222 +- 0.0030), for neutron elastic scattering (typically 0.9587 +- 0.0109) and for inelastic scattering to subthreshold energy for ^{238}U (0.986 +- 0.007). Integral results are compared with various differential data sets using an evaluated ^{252}Cf fission spectrum.

25576 (ICP—1092) **Discrepancies and comments regarding ^{235}U and ^{239}Pu thermal fission yields and the use of ^{148}Nd as a burnup monitor.** Maeck, W.J.; Emel, W.A.; Delmore, J.E.; Duce, F.A.; Dickerson, L.L.; Keller, J.H.; Tromp, R.L. (Idaho National Engineering Lab., Idaho Falls (USA)). Dec 1976. Contract EY-76-C-07-1540. 18p. Dep. NTIS $3.50.

New ^{235}U and ^{239}Pu thermal fission yield values are reported for the isotopes of Kr, Rb, Xe, Cs, and Ba relative to Nd. Differences from previously reported data are large, especially for Xe and Ba isotopes for ^{239}Pu fission. The impact of a large ^{147}Nd capture cross section on ^{148}Nd yield measurements and the use of ^{148}Nd as a burnup monitor are discussed.

25577 (UCID—17324) **Measurement of the neutron-induced fission cross section of ^{241}Am relative to ^{238}U from 0.001 to 30 MeV.** Behrens, J.W.; Browne, J.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Nov 1976. Contract W-7405-ENG-48. 7p. Dep. NTIS $3.50.

The work described in this report represents a continuation of the fission cross section ratio measurements in progress at the Lawrence Livermore Laboratory. Preliminary results are provided for the $^{241}Am/^{235}U$ fission cross section ratio from 0.2 to 30 MeV. Upper limits on this ratio are given over broad energy bands from 0.001 to 0.2 MeV. Using the threshold cross section method, the value of 1.616 +- 0.042 is obtained for the cross section ratio in the interval 1.75 to 4.00 MeV.

25578 **Estimation of nuclear data for ^{235}U in the neutron energy range from 10^{-4} to 1 eV.** Kon'shin, V.A.; Davydovskaya, N.U.; Sukhovitskii, E.Sh. (AN Belorusskoj SSR, Minsk. Inst. Yadernoj Ehnergetiki). *Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk;* No. 1, 13-19(1975). (In Russian).

An estimate was made of data on sigmasub(α), sigmasub(phi,α) and x for U^{235} for neutron energies in the range 10^{-4} eV to 1 eV based on an analysis of experiments by various authors. "Best" curves were found for sigmasub(α)(E) and sigmasub(phi)(E), and a comparison was made of curves for x (E) measured directly, obtained from the ratio of sigmasub(phi) to sigamsub(α), and obtained from the value of α.

25579 **Measurements of energy dependence for ^{233}U in the 0.02-1.0 e range.** Pshenichnyi, V.A.; Blanovskii, A.I.; Gnidak, N.L.; Pavlenko, E.A. *At. Energ. (USSR);* **40**: No. 1, 76-77(Jan 1976). (In Russian).

Letter-to-the-editor; for English translation see the journal Sov. J. At. Energy.

NUCLEAR THEORY

REFER ALSO TO CITATION(S) 25535

NUCLEAR STRUCTURE

25580 (COO—3235-77) **Nuclear excitations and reaction mechanisms. Progress report, November 1, 1975—October 31, 1976.** (Brown Univ., Providence, R.I. (USA). Dept. of Physics). 1 Nov 1975. Contract EY-76-S-02-3235. 25p. Dep. NTIS $3.50.

Theoretical research on nuclear excitation and reaction mechanisms is summarized. A list of publications is included. (JFP)

25581 (ORO—4856-49) **Single-particle Schroedinger fluid. I. Formulation.** Kan, K.K.; Griffin, J.J. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). Jan 1976. Contract EY-76-C-05-4856. 86p. Dep. NTIS $5.00.

The problem of a single quantal particle moving in a time-dependent external potential well is formulated specifically to emphasize and develop the fluid dynamical aspects of the matter flow. This idealized problem, the single-particle Schroedinger fluid, is shown to exhibit already a remarkably rich variety of fluid dynamical features, including compressible flow and line vortices. It provides also a sufficient framework to encompass simultaneously various simplified fluidic models for nuclei which have earlier been postulated on an ad hoc basis, and to illuminate their underlying restrictions. Explicit solutions of the single-particle Schroedinger fluid problem are studied in the adiabatic limit for their mathematical and physical implications (especially regarding the collective kinetic energy). The basic generalizations for extension of the treatment to the many-body Schroedinger fluid are set forth.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 25580

25582 (LBL—5057) **Experimental evidence and physical implications of the time evolution along the mass asymmetry mode in heavy ion reactions.** Moretto, L.G.; Schmitt, R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1976. Contract W-7405-ENG-48. 103p. (CONF-760943—2). Dep. NTIS $5.50.

From Conference on nuclear physics with heavy ions; Caen, France (6 Sep 1976).

The complex experimental features associated with the mass or charge distributions, and with the angular distributions as a function of fragment mass or charge, are interpreted as evidence of an intermediate structure, or intermediate complex, evolving in time along the mass asymmetry mode. Strong circumstantial evidence suggests that this time evolution is diffusive in nature and can be described in terms of the Master Equation or the Fokker-Planck Equation. The experimental evidence of broad mass distributions for large ratios E/B, where E is the center of mass energy and B is the interaction barrier, and narrow mass distributions peaked at the projectile and target mass for small ratios E/B, is interpreted as due to an increasing lifetime of the complex with energy. For short lifetimes, the system has little time to evolve in mass asymmetry and gives rise to rather narrow distributions centered about the target and projectile mass. For long lifetimes the system undergoes extensive relaxation in mass asymmetry and gives rise to very broad mass distributions. Similarly the angular distributions seem to evolve from side peaked to forward peaked with increasing E/B. This is interpreted as due to a transition from a short lifetime-slow angular velocity regime which does not allow for orbiting beyond 0^{0}, to a long lifetime-large angular velocity regime which produces orbiting past 0^{0}. The evolution from side peaking to forward peaking in the same reaction as one moves away in Z from the projectile is interpreted as due to the time lag introduced by diffusion in the population of fragments farther removed in Z from the projectile. The variation of charge and angular distribution with the fragment kinetic energy allows one to connect the energy relaxation to the mass asymmetry relaxation. Theoretical calculations based on diffusion models allow one to fit mass and angular distributions as well as to extract transition probabilities and Fokker-Planck coefficients.

25583 (TID—27314) **Third summer study on high-energy heavy-ion physics, Lawrence Berkeley Laboratory, 12—16 July 1976.** (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1976. Contract W-7405-ENG-48. 226p. Dep. NTIS $8.00.

Talks presented at the Third Summer Study on High Energy Heavy Ion Physics at the Lawrence Berkeley Laboratory 12-16 July 1976 are assembled. Contributions from all 11 speakers are included, most of which are in outline form only. (SDF)

SPONTANEOUS AND INDUCED FISSION

25584 (ANL—76-90, pp 3-30) **Theory of nuclear fission: a review.** Mosel, U. (Univ., Giessen, Ger.). 1976.

From NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239; Argonne, Illinois, United States of America (USA) (28 Jun 1976).

In Proceedings of the NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-238, and Pu-239.

General properties of nuclear fission are reviewed and related to our present knowledge of fission theory. For this purpose the basic reasons for the shape of the fission barriers are discussed and their consequences compared with experimental results on barrier shapes and structures. Special emphasis is put on the asymmetry of the fission barriers and mass-distributions and its relation to the shells of the nascent fragment shells. Finally the problem of calculating fission cross sections is discussed.

RADIATION AND SHIELDING PHYSICS

RADIATION PHYSICS

REFER ALSO TO CITATION(S) 25496, 25497, 25526

25585 (CONF-761037—1) **Transport calculations and sensitivity analyses for air-over-ground and air-over-seawater weapons environments.** Pace, J.V. III; Bartine, D.E.; Mynatt, F.R. (Oak Ridge National Lab., Tenn. (USA)). 1976. Contract W-7405-ENG-26. 11p. Dep. NTIS $3.50.

From Symposium on target vulnerability and survivability at naval surface weapons center; Silver Springs, North Dakota, United States of America (USA) (26 Oct 1976).

Two-dimensional neutron and secondary gamma-ray transport calculations and cross-section sensitivity analyses have been performed to determine the effects of varying source heights and cross sections on calculated doses. The air-over-ground calculations demonstrate the existence of an optimal height of burst for a specific ground range and indicate under what conditions they are conservative with respect to infinite air calculations. The air-over-seawater calculations showed the importance of hydrogen and chlorine in gamma production. Additional sensitivity analyses indicated the importance of water in the ground, the amount of reduction in ground thickness for calculational purposes, and the effect of the degree of Legendre angular expansion of the scattering cross-sections (P/sub l/) on the calculated dose.

25586 (CONF-761059—2) **Measurements of distributions of energy loss and additivity of energy loss for 50 to 150 keV protons in hydrogen and nine hydrogen gases.** Thorngate, J.H. (Oak Ridge National Lab., Tenn. (USA)). 1976. Contract W-7405-ENG-26. 14p. Dep. NTIS $3.50.

From 4. annual conference on the use of small accelerators; Denton, Texas, United States of America (USA) (25 Oct 1976).

Detailed measurements of energy-loss distributions were made for 51, 102 and 153 keV protons traversing hydrogen, methane, ethyne, ethene, ethane, propyne, propadiene, propene, cyclopropane and propane. Less detailed measurements were made at 76.5 and 127.5 keV. To simplify comparison with theory, all of the measurements were made at a gas density that gave a 4% energy loss. The mean energy, second central moment (a measure of the width of the distribution) and the third central moment (a measure of the skew) were calculated from the measured distributions. Stopping power values, calculated using the mean energy, agreed with the predictions of the theory by Bethe. For the second and third central moments, the best agreement between measurement and theory was obtained when the classical scattering probability was used for the calculations; but the agreement was not good. In all cases, variations were found in the data that could be correlated to the type of carbon binding in the molecule.

SHIELDING CALCULATIONS AND EXPERIMENTS

25587 (ORNL-tr—4281) **Gamma dose transmission factors in various shields.** Gagou, B. (Laboratoire Central de l'Armement, 94 - Arcueil (France). Service Etudes Theoriques). 25 Oct 1974. Translation by E.G. Silver of French report. 91p. Dep. NTIS $5.00.

The variation of the gamma dose transmission factor as a function of the thickness of flat shields of concrete, steel, or earth, for radiations coming from nuclear explosions is considered. The code PLING for solving the Boltzmann equation by invariant embedding for gamma radiation is included. 56 figures, 5 tables.

25588 (ORNL-tr—4193) **RSYST: short description of the modules.** Ruehle, R. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Kernenergetik). Apr 1976. Translation by E.G. Silver of IKE—4-5. 270p. Dep. NTIS $9.00.

Since 1969, the modular system RSYST has been used for reactor and shielding calculations. A data base managed by a central program, data blocks containing structure descriptions, and hierarchical linking of data blocks enable flexible management of all data. Module sequences are formulated using a user command language. The language features logical branches, variables and arithmetic expressions. Sections of the user language may be stored in the data base and activated at any time. Presently, an interactive version of the system is developed. It supports basic operations and interactive input checking on a front end computer.

25589 **Shielding calculation techniques for the design of plutonium processing facilities.** Gillett, T.C. (C. F. Braun and Co., Alhambra, CA); Denning, R.S.; Ridihalgh, J.L. *Nucl. Technol.;* **31**: No. 2, 244-249(Nov 1976).

Techniques have been developed for the shield design computations of facilities for the handling and processing of plutonium. These techniques involve the application of a modified version of the point kernel code QAD. Because this modified point kernel code maintains the three-dimensional flexibility and computational efficiency of other point kernel codes, it is well suited to the performance of production shielding-design calculations. Correction factors were developed to account for some inadequacies of the point kernel approach. The accuracy of the code has been determined by comparing results obtained for typical shield configurations with ANISN results and has been found to be adequate for most shielding problems encountered in facilities of this type. Limited comparison to available experimental data indicates the techniques give reasonably good accuracy. Sources of radiation considered include neutrons and gammas from fission, neutrons from (α,n) interactions with light elements, and low-energy gammas from alpha decay. (5 figures, 6 tables)

NEUTRON INTERACTIONS WITH MATTER

REFER ALSO TO CITATION(S) 25585, 25588, 25716

25590 (LA-UR—77-59) **Energy dependent finite element method for two-dimensional diffusion problems.** Komoriya, H.; Walters, W.F. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 19p. (CONF-770304—4). Dep. NTIS $3.50.

From Analysis of nuclear systems; Tucson, Arizona, United States of America (USA) (28 Mar 1977).

The effectiveness of the energy dependent finite element method (EDFEM) as applied to two-dimensional multigroup diffusion problems is investigated. The EDFEM couples the finite element method (FEM) formalism with the energy dependent element size scheme. The EDFEM allows the elements to straddle material interfaces if certain conditions are satisfied; this makes this method especially suitable for heterogeneous reactor calculations. Comparisons of the results obtained by the EDFEM, the FEM, and the finite difference method for a ZION-I PWR model are presented. A significant reduction of the total number of unknowns involved in the problem is accomplished using the EDFEM which yields a reduction of the computing time by 30 percent.

25591 (ORNL-tr—4293) **Program MICRAL: calculation of multi-group cross sections and transfer matrices.** Grandotto, M.; Kavenoky, A.; Lorain, H. [nd]. Translation by E.G. Silver of French report. 61p. Dep. NTIS $4.50.

The purpose of MICRAL is to calculate multigroup cross sections and transfer matrices (corresponding to Legendre polynomials of order 0 and 1) starting with the data on the DOMINO tape, for each isotope occurring in a multigroup calculation. With this program one may place the resulting cross sections on tape. If desired the program will also perform mixing of isotopes. The lethargy group structure may be whatever is desired, and may also include a thermal group. Details of the theoretical formalism and use of MICRAL are given. An appendix discusses the format of the DOMINO tape. (SDF)

MEDICAL PHYSICS

RADIATION PROTECTION STANDARDS

REFER ALSO TO CITATION(S) 24493

DOSIMETRY

25592 (LA-UR—76-2529) **Biological effects of negative pions.** Raju, M.R.; Amols, H.I.; Bain, E.; Carpenter, S.G.; Dicello, J.F.; Frank, J.F.; Tobey, R.A.; Walters, R.A. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 33p. (CONF-760946—5). Dep. NTIS $4.00.

From Particles and radiation therapy conference; Berkeley, California, United States of America (USA) (15 Sep 1976).

Most pion radiobiological work in the past was done at low dose rates using biological systems sensitive to small doses. Biological effects at the beam entrance were found to be nearly the same as conventional radiations, although some reports have indicated a higher RBE. LET distribution at the peak of a nearly monoenergetic pion beam is not much different from fast neutrons; therefore, one would expect similar biological responses, and the results are consistent with this hypothesis. The RBE at the peak for a nearly monoenergetic pion beam is significantly higher than at the entrance. The RBE peak/RBE plateau ratio is decreased with increasing width of the peak. The OER (approximately 1.6) at the peak for a nearly monoenergetic pion beam is also similar to fast neutrons and is expected to increase with increasing width of the peak. No OER data for broad peaks relevant to therapy are available. Preliminary measurements on radiosensitivity variation as a function of cell cycle indicate that there is a slight reduction in variation at the plateau, compared to X-rays, and a significant reduction at the narrow peak.

SOLID STATE PHYSICS

REFER ALSO TO CITATION(S) 25059, 25500

25593 (BNL—21864) **Recent results in relaxation theory: non-stationary processes and polarization effects.** Blume, M. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract EY-76-C-02-0016. 11p. (CONF-760938—2). Dep. NTIS $3.50.

From International conference on the applications of the Mossbauer effect; Corfu, Greece (13 Sep 1976).

A summary is given of theoretical results concerning line-shape in the presence of non-stationary perturbations, and of the polarization of radiation emitted by a nucleus influenced by time-dependent fields.

25594 (BNL—21938) **Dipole interactions and trapping effects of positive muons in fcc and bcc metals.** Straub, G.K.; Parkin, D.M. (Brookhaven National Lab., Upton, N.Y. (USA)). 1976. Contract EY-76-C-02-0016. 7p. (CONF-761027—5). Dep. NTIS $3.50.

From International conference on properties on atomic defects on metals; Argonne, Illinois, United States of America (USA) (18 Oct 1976).

In this paper the results of calculations for a single muon trapped at various lattice sites in an external magnetic field are presented. As the direction of the magnetic field is changed, the results show a large variation of the local field experienced by a muon at the octahedral (o-sites) and tetrahedral (t-sites) symmetry lattice interstitial sites. These results show that a careful measurement of the μi depolarization rate for various external magnetic field orientations would indicate a preferential position for the trapped particle. At this time analysis of the experimental data does not present a clear interpretation for the determination of the μi site. The calculational procedure is outlined and the results, including an estimate of the effects of lattice distortion on the μi depolarization rate when the muon is localized are presented.

25595 (TID—27281) **Surface-plasmon excitation in diffraction gratings: dependence on groove profile.** Wheeler, C.E. Jr. (Oak Ridge National Lab., Tenn. (USA)). Aug 1975. Contract E(40-1)-GEN-33. 147p. Dep. NTIS $6.00.

Thesis.

Excitation of nonradiative surface plasmons in grating surfaces by incident photons has been studied by measuring reflectance versus angle of incidence. Dips in reflectance due to absorption of photons in the excitation process have been analyzed in terms of the Elson-Ritchie theory of photon to surface-plasmon conversion.

25596 **Nuclear quadrupole resonance.** Schultz, H.D. (Bureau of Mines, Morgantown, WV). *Inorg. Chem.;* **1**: 301-346(1970).

The subject of nuclear quadrupole resonance is reviewed. Theoretical aspects are discussed first: electric quadrupole moment, electric field gradient, nuclear quadrupole resonance, and methods for measuring quadrupole coupling constants (pure quadrupole resonance, Zeeman effect, nuclear magnetic resonance, microwave spectrum, Moessbauer spectroscopy, other techniques). Factors affecting the resonance signal include static and dynamic influences on the line width and the position of the resonance signal. Instrumentation is briefly described. The correlation of nuclear quadrupole coupling constants with molecular structure is treated. Applications to halides (Group III, Group IV, transition metals, hexahalides in heavy atoms, etc.), nitrogen quadrupole resonance, minerals (chemical and structural properties, order—disorder phenomena), and quantitative analysis are examined. 6 figures, 7 tables, 77 references. (RWR)

25597 **Dispersion relation for the 3.8 eV volume plasmon of silver.** Zacharias, P. (Univ., Hamburg); Kliewer, K.L. *Solid State Commun.;* **18**: No. 1, 23-26(1976).

The dispersion curve of the 3.8 eV volume plasmon of Ag has been obtained by electron energy loss measurements for wave vectors q in the range 0.1 much less than q much less than 0.35 A^{-1}. Results from the low-q end of this range match well with the optical results of Lindau and Nilsson. The curve can be described by a dispersion constant $\alpha = 0.8 +- 0.1$ and the intensity of the loss goes like I approximately q/sup -2.9+-0.4/. A simple model for the longitudinal dielectric function yields results in good agreement with the experimental conclusions.

SUPERCONDUCTIVITY

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 25009, 25010, 25032, 25033, 25034, 25035, 25053, 25054, 25055, 25056, 25057, 25058, 25065, 25103, 25104

25598 (TID—27221) **Experimental studies in solid state and low temperature physics. Progress report for 1976.** Goldman, A.M.; Weyhmann, W.V.; Zimmermann, W. Jr. (Minnesota Univ., Minneapolis (USA). School of Physics). Sep 1976. Contract EY-76-S-02-1569. 34p. Dep. NTIS $4.00.

Experimental investigations are being carried out in a broad area of low-temperature and solid-state physics which includes superconductivity, magnetism in metals and liquid and solid helium. The pair-field susceptibility of superconductors is being studied. A propagating mode in the phase of the superconducting order parameter is under investigation. Superconducting fluctuations are being used to probe critical fluctuations in magnetic systems using the proximity effect. Heat capacities of super-conducting films in the vicinity of T/sub c/ are also being investigated. The properties of thin film solid solutions of sodium in ammonia are being studied. Nuclear orientation studies of the dilute magnetic impurity problem in metals in the 1 mK temperature region are being carried out. Refrigeration requirements for this work are being met using enhanced hyperfine nuclear cooling. The quantization of circulation in superfluid liquid ^{4}He is being investigated using the Vinen method. The dynamics of superfluid flow through submicron pores are being studied in both pure ^{4}He and in ^{3}He/^{4}He mixtures in an apparatus provided with a ^{3}He refrigerator. The same apparatus is being used to study second sound in ^{3}He/^{4}He mixtures. Measurements of the differential osmotic pressure of ^{3}He/^{4}He liquid mixtures near the tricritical point have shown a peak in the "concentration susceptibility" at the lambda line. Data obey a simple tricritical scaling relation with some discrepancy visible for T < T/sub lambda/.

THEORETICAL PHYSICS

GENERAL AND MISCELLANEOUS

25599 (ORO—3992-292) **Universal time versus relativistic time in four-dimensional symmetry framework.** Chiu, C.B.; Hsu, J.P.; Sherry, T.N. (Texas Univ., Austin (USA). Center for Particle Theory). Dec 1976. Contract E(40-1)-3992. 31p. Dep. NTIS $4.00.

A new four-dimensional symmetry framework with a universal time is investigated which can be realized by a radioactive clock—the measured survival fraction of unstable particles gives the elapsed time. The world picture turns out to be quite different from that in special relativity. The general space-light transformation and the nonuniversal speed of light in this framework are discussed. The difference between the one-way speed and the two-way speed of a light signal is considered in detail. Moreover, the discussion sheds light on the connection between the universality of the light speed and the clock which does not read universal time. The relation with special relativity theory is examined in a few cases.

CLASSICAL AND QUANTUM MECHANICS

REFER ALSO TO CITATION(S) 25581

25600 (UCID—17306) **KOVEC user's manual.** Woodruff, J.P. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Nov 1976. Contract W-7405-ENG-48. 89p. Dep. NTIS $5.00.

KOVEC is a one-dimensional, Lagrangian, elastic—plastic material motion code that is available for both 7600 and STAR computers. The elastic—plastic formulation is in the principal stress

coordinate system; the von Mises yield condition is used. Models for work hardening and temperature- and pressure-dependent yield strength and shear modulus are available. The hydrodynamic equations of state are analytic functions of relative volume and total internal energy. The coding allows an unlimited number of voids to open and close. The present document describes both the physics models and the user features of the KOVEC code. 3 figures, 5 tables.

STATISTICAL PHYSICS AND THERMODYNAMICS

25601 (COO—2203-5) **Brownian motion of interacting particles.** Ackerson, B.J. (Colorado Univ., Boulder (USA). Dept. of Physics and Astrophysics). 1976. Contract EY-76-S-02-2203. 254p. Dep. NTIS $9.00.

Thesis.

Guided by the descriptions which are used to describe noninteracting particles, it is argued that the generalized Smoluchowski equation, including the hydrodynamic interaction and corrections for ion cloud effects may be used to describe interacting particles for the temporal and spatial regimes probed by light beating spectroscopy. This equation is then used to find cumulants of decay of the intermediate scattering function. The generalized Smoluchowski equation is reduced to a simple diffusion equation. The resulting diffusion constant depends upon the interparticle forces and is reminiscent of some early descriptions for interacting systems. The generalized Smoluchowski equation is solved for the model system of a linear chain of colloidal particles interacting via nearest neighbor harmonic couplings. The results for the intermediate scattering function and the static structure factor are very reminiscent of corresponding measurements made for interacting colloidal systems. (GHT)

25602 (LA-tr—76-32) **Formation of structures in nonlinear media and nonequilibrium thermodynamics of aggravation regimes.** Zmitrenko, N.V.; Kurdyumov, S.P.; Mikhaylov, A.P.; Samarskii, A.A. (AN SSSR, Moscow. Inst. Prikladnoj Matematiki). 1976. Translation of Preprint 74. 63p. Dep. NTIS $4.50.

In a medium, the description of which includes quasilinear transport equations (the thermal conductivity, conductivity and viscosity coefficients depend on temperature, density and magnetic field), the effect of nonlinear bulk heat sources, under specific conditions, generates strongly nonequilibrium processes, the so-called regimes with aggravation. They can cause heat localization and magnetic field phenomena on certain space scales or in certain sections of the mass in a compressible medium. This results in different spatial distribution of the quantities indicated, i.e., development of different types of structures in the medium. The work, on the basis of consideration of the quasilinear thermal conductivity equation with nonlinear bulk heat sources, found the characteristics of the strongly nonequilibrium thermodynamics which cause such a complication of organization of the medium. 88 references.

MATHEMATICAL PHYSICS

REFER ALSO TO CITATION(S) 25728

25603 **Mapping technique for efficient random event generation with constraints.** Chen, M.S. (Stanford Univ., CA); Peierls, R.F. *J. Comput. Phys.;* **16**: No. 3, 195-220(Nov 1974).

A new technique for handling Monte Carlo integrations with delta-function constraints is presented. Points are generated in the unconstrained volume and then mapped by a scale transformation or other mapping onto the constrained subspace. The correct weight factors associated with such mappings are given for n-particle phase space with energy—momentum conservation constraints. The flexibility and simplicity of this scheme are discussed in comparison with existing alternative methods.

25604 **Almost periodic solutions of the KdV equation.** Lax, P.D. (New York Univ.). Contract AT(11-1)-3077. *SIAM Rev.;* **18**: No. 3, 351-375(Jul 1976).

The almost periodic behavior in time of space periodic solutions of the KdV equation, u/sub t/ + uu/sub x/ + u/sub xxx/ = 0, is discussed. A new proof, based on a recursion relation of Lenart, is given for the existence of an infinite sequence of conserved functionals, F/sub n/(u), of form $\int$P/sub n/(u)dx, P/sub n/ a polynomial in u and its derivatives. The following result is reviewed and extended: the functions u minimizing F/sub N+1/(u) subject to the constraints F/sub j/(u) = A/sub j/, j = 0, ..., N, form N-dimensional tori which are invariant under the KdV flow. The extension consists of showing that for certain ranges of the constraining parameters A/sub j/ the functional F/sub N+1/(u) has minimax stationary points; these too form invariant N-tori. The Hamiltonian structure of the KdV equation, which is used in these studies, is described briefly. In an Appendix, numerical studies of the stability of some invariant 2-tori for the KdV flow are described; the numerical evidence points to stability.

MAGNETIC FUSION ENERGY

25605 **Technology index for plasmaphysics research and fusion reactors, Volume 10, No. 11, 1976. Bibliography, author index, subject index, appendix.** Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1976). 44p.

This bibliography contains 242 references on various aspects of plasma physics and controlled thermonuclear research. Author and subject indexes are included. (MOW)

PLASMA RESEARCH

PLASMA CONFINEMENT AND HEATING

25606 (COO—2218-69) **Plasma heating via clampling and controlled thermal runaway.** Miley, G.H. (Illinois Univ., Urbana (USA)). 1976. Contract EY-76-S-02-2218. 23p. (CONF-760958—5). Dep. NTIS $3.50.

From 3. international symposium of plasma physics on heating in torodial devices; Varenna, Italy (6 Sep 1976).

Analysis of heating by compression clamping of superthermal ions and also by controlled thermal runaway is described. Application of clamping to the Tokamak Fusion Test Reactor (TFTR) is considered in some detail. With the injectors presently envisioned for TFTR, sequential injection and clamping give an energy multiplication (Q-value) of order of approximately 0.7. A Q-value over unity is possible, however, if the half-energy component of the injected beam is removed without reduction in input power, and if simultaneous injection and clamping are possible. Ignition of D—T plasma via clamping followed by a controlled thermal runaway is proposed to ignite a catalyzed-D Tokamak. The plasma composition is gradually changed during the thermal excursion such that the proper D—T—^{3}He is ultimately achieved. Of the time-temperature trajectories considered for this, the most attractive involves strong clamping followed by a gradual expansion of the radius to control the runaway.

25607 (PPPL—1315) **Radial boundary layers in diffusing toroidal equilibria.** Rosen, M.D.; Greene, J.M. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jan 1977. Contract E(11-1)-3073. 45p. Dep. NTIS $4.00.

Analytic results in straight cylindrical geometry imply sharp density gradients near the boundary of a plasma decaying by classical diffusion. Utilizing an isothermal one-fluid magnetohydrodynamic model, we apply these results to toroidal configurations and obtain a set of nonlinear equations for a radial boundary layer. A dominant effect in this regime is convective plasma flow along magnetic lines of force, with velocity in the sonic range. This flow pattern matches onto the interior solution of Pfirsch-Schlueter convective flow. Solutions separable in the radial and poloidal directions are found that fulfill both boundary and periodicity conditions, and that result in both smooth subsonic poloidal flow, and weak shock transonic flows. Effects of the flow patterns on diffusion are discussed.

25608 **Decoupled electrons and abnormal diffusion of electrons trapped in local mirrors of the TFR Tokamak.** *Nucl. Fusion;* **16**: No. 3, 473-490(1976). (In French).

The holes in the TFR vacuum chamber have been produced by 50-keV electrons trapped in the local troughs of the toroidal magnetic field. Phenomena associated with the creation of these electrons are described.

25609 **Effects of particle trapping on the slowing-down of fast ions in a toroidal plasma.** Cordey, J.G. (UKAEA Research Group, Abingdon. Culham Lab.). *Nucl. Fusion;* **16**: No. 3, 499-507(1976).

The effect of toroidal geometry upon the slowing-down of fast ions in a tokamak plasma is considered. An appropriate bounce-averaged Fokker-Planck equation which includes particle trapping in the toroidal field gradient is derived. The equation is solved by expressing the solution in terms of a series of 'finite-geometry' eigenfunctions. This solution is then used to show that the trapping of the fast ions in the toroidal field gradient reduces the fast-ion current by terms of order (r/R)1/2. The radial transport of the fast ions as they slow down is calculated, and it is found that for counter-injection (co-injection) the ions diffuse outwards (inwards) by approximately a fast-ion banana width. The diffusion is accompanied by a loss of fast-ion toroidal momentum and a consequent reduction in the momentum transferred to the background plasma.

25610 **RF-heating near the lower hybrid frequency in the FM-1 spherator.** Hawryluk, R.J.; Davis, S.L.; Schmidt, J.A. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). *Nucl. Fusion;* **16**: No. 3, 419-426(1976).

Plasma heating experiments at frequencies near the lower hybrid frequency have been carried out at modest powers (0.05-

4kW). The antenna structure operating at 68 MHz was comprised of two plates driven out of phase on the exterior of the plasma. High electron heating efficiency (<40%) in both helium and argon plasmas was observed with only a weak density dependence. At low densities (nsub(e) approximately less than $1x10^{11}$ cm^{-3}), the heating was uniform across the plasma while at higher densities the heating was preferentially on the exterior portion of the plasma. The heating of the exterior of the plasma was found not to correspond to absorption at the lower hybrid resonance layer. The electron heating efficiency was found to be a weak function of the RF-power when the incident RF-power was varied from 1 to 15 times the experimentally observed threshold power for parametric instabilities. Ion temperatures were determined by measuring the Doppler broadening of an argon ion line using a Fabry-Perot interferometer. Low-efficiency main-body ion heating (1-3%) was observed.

25611 Detailed ambipolar balancing in tokamak diffusion. Hazeltine, R.D.; Ware, A.A. (Texas Univ., Austin (USA)). *Nucl. Fusion;* **16**: No. 3, 538-541(1976).
Letter-to-the-editor.

25612 Condition for absolute confinement of alpha-particles in axisymmetric tori. Ikuta, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). *Nucl. Fusion;* **16**: No. 3, 536-538(1976).
Letter-to-the-editor.

25613 Multiple-mirror confinement with collision-independent scattering. Lichtenberg, A.J.; Lieberman, M.A. (California Univ., Berkeley (USA). Electronics Research Lab.). *Nucl. Fusion;* **16**: No. 3, 532-534(1976).
Letter-to-the-editor.

25614 Heating of a long plasma column with the help of laser radiation. Sharma, S.C.; Verma, J.S. (Birla Inst. of Tech. and Science, Pilani (India). Dept. of Physics). *Indian J. Pure Appl. Phys.;* **14**: No. 6, 508-509(Jun 1976).
Published in summary form only.

25615 Lower hybrid resonance. Its dependence on impurities and ion-Larmor radii in hot TOKAMAK plasmas. Wilhelmsson, H. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de la Physique du Plasma et de la Fusion Controlee). *Phys. Scr.;* **14**: No. 1-2, 60-62(Jul 1976).
The form of the relation describing the lower-hybrid resonance is examined including its dependence on impurities as well as ion-Larmor radii. For typical TOKAMAK parameters a shift of the resonance frequency amounting to a decrease by 7% in the case of oxygen (fractional content 4%) and by 5% for the carbon (fractional content 4%) and by 2% for molybdenum (fractional content 0.2%) as compared to the hot case without impurities is calculated.

25616 Synergistic effects of simultaneous beam and RF plasma heating. Jones, R. (General Atomic Co., San Diego, Calif. (USA)). *Phys. Lett., A;* **58**: No. 5, 307-309(20 Sep 1976).
Experimental observations with electron beam-plasma interactions are used to show that a positive feedback destabilization can occur when a beam and RF are applied simultaneously to a plasma, resulting in an enhanced overall heating efficiency.

PLASMA DIAGNOSTICS

REFER ALSO TO CITATION(S) 25644, 25691, 25695

25617 (EUR-CEA-FC—814) **Thomson scattering measuring device using high sensitivity photomultipliers: 16% up to 860nm.** Hesse, M. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Mar 1976. 43p. (In French). INIS.
Photomultipliers with high quantum efficiency were used to observe the entire ruby laser light spectrum scattered by a plasma. The optical and electronic acquisition device used to study this spectrum is described. The spectra obtained revealed a dissymmetry larger than that expected from relativistic theory. These results could not be interpreted. The diagnostic sensitivity allows the measurement of low electron densities ($2x10^{12}cm^{-3}$).

25618 (EUR-CEA-FC—815) **To the question of ion temperature measurement with far infrared lasers.** Magyar, G. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Mar 1976. 18p. INIS.
Problems concerning plasma diagnostics in Tokamak devices using laser beam Thomson scattering are discussed. The conclusions drawn are in disagreement with previous results obtained by other searchers.

25619 (IMP—32/712/72) **Direct reading microwave interferometer for measurements of the local electron density in a plasma.** Zakrzewski, Z.; Lubanski, M.; Kopiczynski, T.; Sicha, M. (Polska Akademia Nauk, Gdansk. Instytut Maszyn Przeplywowych). 1972. 21p. (In Polish). INIS.
The direct reading microwave interferometer for measurments of the local electron density in a low-pressure plasma has been described and the performance principle has been discussed. In this interferometer, which operates in X band, special phase-sensitive detecting system and the section of the Lecher line together with two field transformers to create converged microwave fields in the examined plasma are used. Some results of the measurements which have been carried out using the interferometer are presented. The reported sensitivity is about $4.10^9 cm^{-3}$ and accuracy 10%. The space resolutions in two directions perpendicular to the Lecher line are about 10 mm and 5mm. The time resolution depends on the properties of semiconductor diodes and amplifiers of the used oscilloscop.

25620 (IPF—75-7) **Measuring method for single light pulses in the picosecond regime.** Warich, L. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Plasmaforschung). 1975. 50p. (In German). INIS.
14 figs.; 25 refs.
The time resolution of very short light pulses (<1 ns) is important in the investigation of non-linear absorption processes and laser-generated plasmas. A scanning principle is discussed which enables direct measurement of the time lapse of single light pulses. A light pulse chain is generated from the single pulse by beam splitting and different transit times of the single beams of light. For a pulse interval of 10 ns, a scanning pulse generator with continuously adjustable interval is described which is triggered by the first pulse of the chain. An additional optical delay line ensures that the first pulse of the chain is also used for measurement. This delay line also enables easy scanning of sections of the pulse curve at any time interval in the 10 ns region. A measuring system based on this principle enables the measuring of pulses of a band width of 4 GHz (in dependence of the photoreceiver diodes used) with an input sensitivity of about 10 mV. The time variation of the beginning of the scanning pulse chain is about 50 ps. The variation of the pulse interval is +- 20 ps, and the difference between the lengths of the scanning pulses has been determined with an accuracy of +- 25%. The largest gate opening time results in a band limitation of the electronic system to about 10 GHz.

25621 (LA-UR—76-2695) **Multiwave picosecond laser interferometry of CO_2-laser produced plasmas.** Carman, R.L.; Engelhardt, A.G.; Clabo, N. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-ENG-36. 21p. (CONF-761155—1). Dep. NTIS $3.50.
From 4. workshop on laser interaction and related plasma phenomena; Troy, New York, United States of America (USA) (8 Nov 1976).
The plasma illumination source and its synchronization with the fusion laser are discussed. Some interferograms taken with a He-Ne laser are presented. The plasma physics and data acquisition problems involved are also described. (MOW)

25622 Picosecond microphotography as a diagnostic method for laser produced plasmas. Ariga, S.; Sigel, R. (Max-Planck-Gesellschaft zur Foerderung der Wissenschaften e.V., Garching/Muenchen (Germany, F.R.). Projektgruppe fuer Laserforschung). *Z. Naturforsch., a;* **31**: No. 7, 697-706(Jul 1976).
12 figs.; 1 tab.; 13 refs.
A single picosecond pulse from a mode-locked dye laser was used for time resolved microphotography of the gasdynamic phenomena occurring in a laser-target interaction experiment. A time resolution of 5 ps and a spatial resolution of better than 10 μm were experimentally obtained. Results are presented for the case of laser irradiation of a thin foil, shock wave propagation in a transparent target, expansion of the hot plasma and blast wave formation in a background gas.

25623 Intensity measurements of extreme ultraviolet radiation from helium plasma by photoelectron spectroscopy. Sato, K.; Hosokawa, M.; Ishii, K.; Sugawara, H.; Oda, T.; Sasaki, T. (Nagoya Univ. (Japan). Inst. of Plasma Physics). *Phys. Lett., A;* **58**: No. 5, 310-312(20 Sep 1976).
Extreme ultraviolet radiation emitted from He plasma has been studied by means of photoelectron energy analyzer. Relative and absolute intensities of Lyman series of ionized helium have been measured. From these spectral intensities, the electron temperature of the plasma has been estimated at several tens of eV.

25624 High-speed digital measurements of probe characteristics and energy distribution function. Shimizu, K.; Amemiya, H. (Institute

of Physical and Chemical Research, Wako, Saitama (Japan)). *J. Phys., E (London);* **9**: No. 11, 943-946(Nov 1976).

The probe characteristics and the energy distribution function in gas plasmas are measured by a digital electronic apparatus with high speed scanning and a good signal-to-noise ratio. To counteract noise, the apparatus has averaging functions using digital accumulation and multiple scanning. In the multiple scanning, data at each probe voltage step are added in a memory and their average is taken so that low frequency noise may be eliminated. In each single scan, many data are sampled quickly at each probe voltage step, converted to a digital value, accumulated in a memory and averaged so that high frequency random noise may be eliminated. Sampling is done either uniformly or randomly. To eliminate rather coherent noises such as power source ripple and parasitic oscillations in discharge, sampling is synchronized with noise pulses so that data may be taken substantially at the mean value. Finally, the digital accumulation technique is applied to the lock-in detection in the measurement of the energy distribution function by the beat method. This permits high speed scanning without any time lag effect caused by a filter.

PLASMA KINETICS - GENERAL

25625 (COO—2218-77) **Experiences with project-oriented research in graduate engineering education.** Miley, G.H. (Illinois Univ., Urbana (USA)). 1976. Contract E(11-1)-2218. 4p. (CONF-761042—1). Dep. NTIS $3.50.

From Frontiers in education conference; Tucson, Arizona, United States of America (USA) (25 Oct 1976).

Two examples of project-oriented research that involve the conceptual design of fusion systems are described. One of these projects involved close collaboration with workers in a national laboratory while the second was formally organized as a cooperative effort with two other laboratories. An important educational aspect of such research is that the students are involved in a design team composed of both students and professionals facing a realistic problem. In retrospect, it appears that both students and faculty profited from the experience. Several students have taken jobs in related areas, and additional research has resulted at the University from new insight gained during the projects.

25626 (IPF—74-6) **Multi-particle model for the decription of neutron production in the plasma focus.** Ruhs, N. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Plasmaforschung). Oct 1974. 99p. (In German). INIS.

37 figs.; with refs. and app.

Following a comparison of the different numerical methods describing the processes in the plasma focus, the experimental arrangement is firstly explained for which these calculations were performed. A brief descrption of the MHD calculation then follows which provides the basis for the particle calculation. After an outline of the methods used for the particle calculation, the numerical results of the calculations are finally given and discussed in the last part of the work.

25627 (SAND—76-5750) **Space-charge flow in a non-cylindrically symmetric diode.** Quintenz, J.P.; Poukey, J.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1976. Contract E(29-1)-789. 6p. (CONF-761106—1). Dep. NTIS $3.50.

From IEEE international pulsed power conference; Lubbock, Texas, United States of America (USA) (9 Nov 1976).

The one-dimensional cylindrical space-charge-limited emission and flow results of Langmuir and Blodgett are extended to the two-dimensional (r-theta) non-symmetric case by solving a fluid model numerically. It is found that particle beams thus generated can be controlled by suitable adjustment of the applied potentials and cylinder radii. A particle code has been modified to treat razor blade cathodes by including a simplified model for the blade emission. Numerical results are compared with experimental data. These results indicate that beams produced by razor blades pinch less tightly than those from block cathodes, but in some cases may still pinch enough to be interesting.

25628 (TRITA-EPP—76-02) **Velocity limitations in coaxial plasma gun experiments with gas mixtures.** Axnaes, I. (Kungliga Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik). Apr 1976. 26p. INIS.

The velocity limitations found in many crossed field plasma experiments with neutral gas present are studied for binary mixtures of H_2, He, N_2 O_2, Ne and Ar. The apparatus used is a coaxial plasma gun with an azimuthal magnetic bias field. The discharge parameters are chosen so that the plasma is weakly ionized. In some of the mixtures it is found that one of the components tends to dominate in the sense that only a small amount (regarding volume) of that component is needed for the discharge to adopt a limiting velocity close to that for the pure component. Thus in a mixture between a heavy and a light component having nearly equal ionization potentials the heavy component dominates. Also if there is a considerable difference in ionization potential between the components, the component with the lowest ionization potential tends to dominate.

25629 **Dynamics of a cloud of fast electrons travelling through the plasma.** Takakura, T.; Shibahashi, H. (Tokyo Univ. (Japan)). *Sol. Phys.;* **46**: No. 2, 323-346(Feb 1976).

Numerical analysis has been carried out on the one-dimensional quasi-linear relaxation of a group of fast electrons travelling through the plasma. It is demonstrated that the electron velocity distribution of fast electrons tends to be a plateau form exciting the electron plasma waves and that the plasma waves are almost completely reabsorbed later by electrons arriving later. Both the velocity range and time interval in which quasi-plateau distribution is formed increase with distance from the origin of the fast electrons. There is no net energy loss of the electron cloud during the travel through the plasma if both the collisional losses and the scattering of plasma waves are neglected. Although the present computation is preliminary and limited to rather low beam density, it can be seen that the characteristics of both the electron beam and the plasma waves tend, with distance, to those of the analytical solution given by Ryutov and Sagdeev; though a modification to set a low velocity cutoff on the plasma waves due to the thermal electrons is necessary.

25630 **Investigation of the trapping fraction for a coaxial accelerator.** Mair, G.L.R.; Tsagas, N.F.; Prinn, A.E. (Liverpool Univ. (UK)). *Phys. Lett., A;* **58**: No. 5, 315-317(20 Sep 1976).

In this paper the trapping efficiency of the ionizing current sheath (snowplough) in a coaxial accelerator is investigated. It turns out that the trapping efficiency of the snowplough is in general a time dependent quantity and also depends on the initial neutral gas density and current.

25631 **Inverse bremsstrahlung absorption in large radiation fields during binary collisions-classical theory II(b). Summed rate coefficients for Coulomb collisions.** Pert, G.J. (Hull Univ. (UK). Dept. of Applied Physics). *J. Phys., A (London);* **9**: No. 10, 1797-1800(Oct 1976).

The summation of the expressions obtained previously for the value of the absorption coefficient is performed analytically and their asymptotic expansion derived. These results are shown to be in agreement with similar expressions obtained by other methods. It is concluded that this form represents a generalization of the Kramers-Gaunt low-field absorption coefficient.

25632 (LA-tr—77-1) **Formation of a fast electron cloud by injecting a high power relativistic electron beam in a vacuum.** Ryutov, D.D.; Stupakov, G.V. (AN SSSR, Novosibirsk. Inst. Yadernoj Fiziki). 1977. Translation of IYaF—75-111. 25p. Dep. NTIS $3.50.

An analytical description is given of the dynamics of forming a relativistic electron cloud which arises near the anode foil of a high power electron accelerator. It is shown that under certain conditions the density of the cloud can exceed the density of the original relativistic beam by two to three orders of magnitude.

PLASMA KINETICS - THEORETICAL

25633 (EUR-CEA-FC—812) **Transport in Tokamak plasmas. Fontenay ID numerical code and simplified study.** Mercier, C. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Feb 1976. 28p. INIS.

The Fontenay numerical code of toroidal discharges is presented. The empirical rules and transport coefficients used in order to fit the experimental data are explained, and a few examples of application are given. A simplified study of the transport equations in the steady state is presented, it gives precise details about the functional form of the transport coefficients and justifies the empirical coefficients used.

25634 (LA—6661-MS) **PLASMX: multigroup ionization and charge exchange cross-section code for neutral hydrogen transport in plasmas.** Morel, J.E.; Wienke, B.R. (Los Alamos Scientific Lab., N.Mex. (USA)). Jan 1977. Contract W-7405-ENG-36. 33p. Dep. NTIS $4.00.

PLASMX generates effective multigroup macroscopic cross sections for discrete-ordinates calculations of neutral hydrogen atom transport in tokamak systems. The effective microscopic cross sections can be generated at the midpoint energies of the multigroup bin structure. Variable dimensioning presently restricts the number of energy groups to 22, the number of spatial regions to 10, and the number of Legendre polynomial moments to 7 (P_6). (MOW)

25635 **Nonlinear interaction of a parallel-flow relativistic electron beam with a plasma.** Jungwirth, K.; Koerbel, S.; Simon, P.; Vrba, P. (Ceskoslovenska Akademie Ved, Prague. Ustav Fyziky Plazmatu). *Czech. J. Phys.;* **25**: No. 12, 1331-1354(1975).

Nonlinear evolution of single-mode high frequency instabilities (ω approximately equal to ksub(parallel)vsub(b)) excited by a parallel-flow high-current relativistic electron beam in a magnetized plasma is investigated. Fairly general dimensionless equations are

derived. They describe both the temporal and the spatial evolution of the amplitude and phase of the fundamental wave. Numerically, the special case of excitation of the linearly most unstable mode is solved in detail assuming that wave energy dissipation is negligible. The strength of interaction and the relativistic properties of the beam are fully respected by a single parameter lambda. The value of lambda ensuring the optimum efficiency of the wave excitation as well as the efficiency of the self-acceleration of some beam electrons at higher values of lambda < 1 are determined in the case of a fully compensated relativistic beam. Finally, the effect of the return current dissipation is included (phenomenologically) into the theoretical model, its role for the beam-plasma interaction being checked numerically.

25636 General accessibility criterion in multi-component plasmas and effects of impurities. Artico, G.; Spigler, R. (Padua Univ. (Italy)). *Nucl. Fusion;* **16**: No. 3, 542-546(1976).

Letter-to-the-editor.

25637 Numerical computation of axisymmetric MHD-equilibria without conducting shell. Cenacchi, G.; Galvao, R.; Taroni, A. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy). Centro di Calcolo). *Nucl. Fusion;* **16**: No. 3, 457-464(1976).

A numerical scheme for the computation of axisymmetric equilibria in the presence of external conductors, without a conducting shell, is presented. The plasma boundary is always required to pass through a given point in the equatorial plane of the plasma column. The relationship between the convergence of the iterative scheme and the position of this point is discussed. The numerical scheme is applied to two relevant problems.

25638 Calculation of the diffusion of light impurities in tokamaks. Dnestrovskii, Yu.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii); Inovenkov, I.N.; Kostomarov, D.P. (Moskovskij Gosudarstvennyj Univ. (USSR)). *Nucl. Fusion;* **16**: No. 3, 513-519(1976).

Using numerical methods, the authors investigate plasma diffusion in tokamaks when impurity ions of light elements are present. The model considered makes use of neoclassical expressions for diffusion fluxes and takes ionization and recombination processes into account. The question of the boundary conditions for the initial system of equations is discussed. The new boundary conditions for the proton and impurity ion densities are zero partial ion-ion fluxes at the boundary of the plasma column. The computational results show that the presence of impurity ions in the plasma column of a tokamak - even in relatively small amounts - strongly influences the spatial distribution of the protons. The entire diffusion process can be broken down into a number of stages which differ one from the other with regard to the amount of impurities in the system. If the proportion of impurities xisub(im) does not exceed 0.01 of the electron density, the highly ionized ions collect at the centre of the plasma. If xisub(im)<0.01, the proton profile becomes flat within a short time and the impurities become more evenly distributed over the plasma cross-section.

25639 Tokamak equilibria with arbitrary cross-section. Dobrott, D.; Helton, F.J. (General Atomic Co., San Diego, Calif. (USA)). *Nucl. Fusion;* **16**: No. 3, 491-498(1976).

Magnetohydrodynamic equilibria are obtained by semi-analytic means for large-aspect-ratio tokamaks with fixed, non-circular boundaries and slightly non-uniform currents. The method uses the fact that there is a conformal map of any simple closed region onto the unit circle. Solutions are expressed as quadratures which involve the conformal maps. These quadratures are evaluated numerically for specific examples. Results for equilibria with circular, elliptical, dee-shaped and doublet-shaped cross-sections are presented and compared. Toroidal and finite-beta effects are noted and stability against flutes is examined by Mercier's criterion for the various configurations.

25640 Space-dependent effects on the Lawson and ignition conditions and thermal equilibria in tokamaks. Kesner, J.; Conn, R.W. (Wisconsin Univ., Madison (USA). Dept. of Nuclear Engineering). *Nucl. Fusion;* **16**: No. 3, 397-404(1976).

The Lawson and ignition criteria are sensitive to the plasma density and temperature profiles and it is found that peaked profiles lead to a considerable easing of these criteria, as well as to a significant increase in the average fusion power density. Space- and time-dependent reactor plasma calculations show that these profiles may indeed be sharply peaked at the centre owing to alpha heating and to rapid diffusion near the edge. The thermal equilibria are sensitive to the size of the device, to the conditions imposed at the plasma boundary and to the fuelling profile. A comparison between tokamak plasma equilibrium parameters predicted by often used global energy balance models and by space-dependent calculations indicates that the global-model results can differ sharply from the space-dependent calculations with regard to mean temperature, mean density, particle confinement time and fractional burn-up. In particular, the fractional burn-up predicted from global calculations can be too high and therefore strongly affect the anticipated tritium inventory and re-fuelling problems in tokamak reactors.

25641 Adiabatic invariants for a toroidal slightly dissipative plasma. Minardi, E. (UKAEA Research Group, Abingdon. Culham Lab.). *Nucl. Fusion;* **16**: No. 3, 427-431(1976).

In a dissipative plasma the magnetic flux is not conserved. If, however, the dissipation is sufficiently slight, the helical flux in a slowly helically perturbed toroidal plasma is still conserved as an adiabatic invariant, up to first order in the inverse aspect ratio, while the toroidal and the poloidal fluxes are not.

PLASMA PRODUCTION

25642 (IPF—75-5) Experiments on plasma generation using microwave antennas in a magnetic mirror. Staib, W. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Plasmaforschung). 1975. 91p. (In German). INIS.

33 figs.; 43 refs.

Plasma generation by 2.45 GHz microwaves was investigated in the mirror device ELIZA. Two microwave antennas with different HF coupling were used. The microwave power was 5 kW. Electron densities up to 8×10^{11} cm^{-3} and electron temperatures between 46,000 K and 116,000 K were reached in hydrogen. Reproducible plasma ignition was only possible with the aid of electron cylotron resonance. The techniques used are described. For an electron density over 3×10^{11} cm^{-3}, anomalous absorption of the microwave was observed above a certain power threshold. Above this threshold, the measured electron density showed a square dependence on the microwave power. This suggests that the effective collision frequency is proportional to the square of the electric field strength of the radiated microwave.

PLASMA INSTABILITIES

25643 (COO—2218-70) Destabilizing effect of alpha particles in a Maxwellian plasma. Wang, M.Y. (Illinois Univ., Urbana (USA)). 1976. Contract EY-76-S-2218. 53p. Dep. NTIS $4.50.

Thesis.

Various plasma waves which are possibly excited by MeV alphas have been investigated. For a delta birth distribution it is found that: a) The right-circularly polarized Alfven wave can be excited. Its growth rate is linearly proportional to the α-particle density. b) The drift Alfven wave is stable against α-particles. c) For a uniform temperature, the plasma wave spectrum changes from three branches with n/sub $\alpha/ = 0$ to four branches for n/sub $\alpha/$ not equal to 0 case. d) α-particles can destabilize the ion drift acoustic wave even with uniform temperature. However, the ion acoustic wave appears to be stable against fusion products in a fusion grade plasma. e) If their effect on the background plasma spectrum is neglected, α-particles can excite the electromagnetic cyclotron wave in a range of harmonics (band structure). The growth rate is proportional to the square root of α-particle density. f) If the effect of α-particle on the plasma spectrum is included, we find that electromagnetic cyclotron wave is stable.

25644 (IMP—61/746/1973) Experimental set for measurements of plasma instabilities in a magnetic field. Zakrzewski, Z.; Kopiczynski, T.; Lubanski, M. (Polska Akademia Nauk, Gdansk. Instytut Maszyn Przeplywowych). 1973. 32p. (In Polish). INIS.

An experimental set for measurements of electric discharge plasma instabilities in stable and uniform magnetic fields has been described. The methods of producing of a plasma has been discussed as well as the design of the electromagnet, parameters of the magnetic fields and the diagnostic apparatus. The outfit which has been described enables one to carry out investigations of the mechanism of low temperature plasma instabilities. The effort has been made to provide the possibility to measure the time and space dependent structure of a disturbance of plasma parameters.

25645 (PPPL—1310) Study of drift wave turbulence by microwave scattering in a toroidal plasma. Okabayashi, M.; Arunasalam, V. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jan 1977. Contract E(11-1)-3073. 45p. Dep. NTIS $4.00.

A study of drift wave turbulence by microwave scattering technique was carried out in a toroidal plasma confinement device, the FM-1 spherator. The principal results are; (a) Observation of the linear dispersion relation of drift waves in the high magnetic shear condition. The linear dispersion relation is followed up to weak turbulence state (γ approximately less than ω). (b) An experimental demonstration of the stabilization of the drift waves with an increase of the shear strength. In particular, the ion mass dependence of the observed marginal stability criterion for drift waves (ω approximately ω/sub */ was in reasonably good agreement with theoretical expectations. Further, very low frequency (ω much less than ω/sub */ fluctuations were enhanced when the shear strength was lowered. (c) A detailed study of the behavior of drift waves in a weak shear condition where a state of isotropic turbulence was observed.

The turbulent density fluctuations showed a strong dependence on frequency, but no dependence on wave number (somewhat in sharp contrast to theoretical expectations). The possible dependence of the anomalous loss process on the observed drift wave turbulence is also discussed.

25646 (TID—27319) **Parametric instabilities with finite wavelength pump.** Fried, B.D.; Ikemura, T.; Nishikawa, K.; Schmidt, G. (California Univ., Los Angeles (USA). Dept. of Physics). Dec 1975. Contract E(04-3)-0034;E(11-1)-3004. 31p. Dep. NTIS $4.00.

The general problem of parametric instabilities driven by a finite wavelength pump is investigated. For the particular case of a Langmuir wave pump, it is shown that resonant decay instabilities (forward or backward scattering in the one-dimensional case), with thresholds which vanish in the collisionless limit, can occur only for pump wavenumber k_0 greater than the critical value [(m/M)$^{1/2}$/γ]k/ sub D/, where m and M are the electron and the ion mass, respectively, and γ is the specific heat ratio. For smaller wavenumbers, there is always a nonzero threshold, the instability being of modulation character for long wavelengths and almost purely growing for short wavelengths. Frequency locking for small k_0 and wavenumber locking for large k_0 are demonstrated. The results are generalized to the case where the coupled waves satisfy arbitrary dispersion relations and simple physical interpretations of the instabilities are given.

25647 **Stability of trapped-particle modes in lower-hybrid pump.** Chen, L.; Kaw, P.K.; Tang, W.M. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). *Nucl. Fusion;* **16**: No. 4, 661-665(1976).

The stability of dissipative trapped-particle modes in the presence of a self-consistent lower-hybrid pump is analysed theoretically. The pump can either be a single coherent wave or a spectrum of turbulent waves. Corresponding dispersion relations modified by the pump are derived and conditions for excitation and suppression of the modes are also discussed.

25648 **Cyclotron instability of trapped α-particles in a tokamak with elliptic cross-section.** Kaladze, T.D. (Tbilisskij Gosudarstvennyj Univ. (USSR). Inst. Prikladnoj Matematiki); Lominadze, J.G. (AN Gruzinskoj SSR, Tbilisi. Inst. Fiziki); Mikhajlovskij, A.B. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii); Pokhotelov, O.A. (AN SSSR, Moscow. Inst. Fiziki Zemli). *Nucl. Fusion;* **16**: No. 3, 465-472(1976).

Cyclotron excitation of fast magnetosonic waves by trapped α-particles produced by thermonuclear fusion in a tokamak with elliptic cross-section is studied. Earlier, this phenomenon was studied for a tokamak with circular cross-section. It is shown that ellipticity of the tokamak cross-section considerably affects the growth rate of oscillations when A is identical $(l_1/R)(\mathrm{esup}(2\mathrm{eta})-1)/q^2 Wh1$ where R is the radius of curvature of the magnetic axis, q is the tokamak safety factor, and tanh eta=$(l_2-l_2)/(l_2 V_{l_2}2)$, where l_1, l_2 are the minor and major axes of the ellipse, respectively. General expressions for the growth rate of the oscillations are obtained at arbitrary values of the parameter A and are analysed in a limiting case when the wave frequency is close to the cyclotron harmonics of strongly trapped particles. It is shown that the growth rate of oscillations excited by strongly trapped α-particles is considerably smaller at large ellipticity of the tokamak cross-section, 'A<=1, than in the case of a tokamak with circular cross-section.

25649 **Disruptive instability mode structure in the LT-3 tokamak.** Morton, A.H. (Australian National Univ., Canberra. Research School of Physical Sciences). *Nucl. Fusion;* **16**: No. 4, 571-577(1976).

Results of measurements of helical current perturbations associated with the disruptive instability are given for q(a) approximately 3. An m=1, n=1 mode develops between disruptions; fast growing m=2, n=1 and m=6, n=2 (or m=3, n=1) modes, with growth times of approximately 10 μs, accompany the disruptions.

25650 **Non-linear growth of the m=1 tearing mode.** Waddell, B.V.; Rosenbluth, M.N. (Institute for Advanced Study, Princeton, N.J. (USA)); Monticello, D.A.; White, R.B. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). *Nucl. Fusion;* **16**: No. 3, 528-532(1976).

Letter-to-the-editor.

25651 **Ion acoustic parametric decay instability in a plasma with $\beta<1$.** Ionson, J.A.; Ong, R.S.B. (Michigan Univ., Ann Arbor (USA). Space Physics Research Lab.). *Phys. Lett., A;* **58**: No. 6, 393-394(4 Oct 1976).

It is found that in a plasma with $\beta<1$ a finite amplitude ion acoustic wave is unstable and decays into two shear Alfven waves propagating in opposite directions. The threshold and growth rate of the instability are determined.

PLASMA WAVE PHENOMENA

25652 **Modulation of extraordinary electromagnetic wave by the plasma density pulsations.** Serikov, A.V.; Skibenko, A.I.; Fomin, I.P. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). *Ukr. Fiz. Zh. (Russ. Ed.);* **20**: No. 8, 1347-1353(Aug 1975). (In Russian).

6 refs.; for English translation see the journal Ukr. Phys. J.

Analytical relations are obtained which describe the modulation of an extraordinary wave propagating through a plasma with density pulsations across an external magnetic field. The modulation coefficients of the ordinary and the extraordinary waves are compared. The paper describes the results of experimental investigations carried out with the plasma of a reflecting discharge in the millimetre range of waves with the different polarization relative to the external magnetic field, which corresponds to ωsubH = (0.1 - 0.9)ω. The applicability of the modulation measurements of SHF oscillations for plasma diagnostics is discussed.

25653 **Momentum, energy and mass dissipation in an electromagnetic wave packet propagating in a collisional plasma.** Petrzilka, V.A. (Ceskoslovenska Akademie Ved, Prague. Ustav Fyziky Plazmatu). *Czech. J. Phys.;* **26**: No. 2, 151-156(1976).

Plasma is accelerated in a transverse wave packet due to the dissipation of the electromagnetic momentum (radiation pressure effects) and to the dissipation of the mechanical momentum of the wave packet. The quasi-particle description of the wave packet is again possible. However, the quantities appearing in the corresponding energy-mass relation are now time-dependent.

25654 **Effects of an ambient magnetic field on the properties of Langmuir waves.** Melrose, D.B. (Australian National Univ., Canberra. Dept. of Theoretical Physics). *Sol. Phys.;* **46**: No. 2, 511-513(Feb 1976).

From Mechanisms for solar type III radio bursts; Berkeley, Calif., USA (8 May 1975).

In an isotropic plasma Langmuir waves are strictly longitudinal, and their approximate dispersion relation is ω2 approximately $(\omega\mathrm{sub}(p))^2 + 3k^2(\mathrm{Vsub}(e))^2$, where ωsub(p) is the plasma frequency and Vsub(e) is the thermal speed of electrons. In a magnetized plasma it is usually assumed that 'generalized' Langmuir waves are longitudinal, and it then follows that their dispersion relation is given by setting the longitudinal part of the dielectric tensor equal to zero. However, it can be shown that the only waves which are strictly longitudinal in a magnetized plasma are propagating either parallel (theta=0 or π) or perpendicular (theta=π/2) to the ambient magnetic field. Two questions arise. First, under what conditions is the longitudinal approximation valid. Second, when it is not valid, how does one determine the properties of the relevant waves. These two questions are answered and some possible implications for type III bursts are mentioned.

25655 **Simple condition for excitation of slow waves in plasma column.** Sharma, S.C.; Verma, J.S. (Birla Inst. of Tech. and Science, Pilani (India). Dept. of Physics). *Indian J. Pure Appl. Phys.;* **14**: No. 6, 507-508(Jun 1976).

Published in summary form only, 5 refs.

25656 **Dispersive ionization waves with constant group velocity.** Chvoika, M.; Pekarek, L.; Urbankova, H. (Ceskoslovenska Akademie Ved, Prague. Fyzikalni Ustav). *Phys. Lett., A;* **58**: No. 5, 305-306(20 Sep 1976).

Dispersive ionization waves with the linear dispersion relation are discussed. A coupling between the ordinary sound wave and the F^- ionization wave is presented as a possible explanation of the straightening of the free F^- ionization wave dispersion relation.

25657 **Plasma waves in a stochastic magnetic field.** Mittal, M.L.; Prahalad, Y.S. (Indian Inst. of Tech., Bombay. Dept. of Mathematics). *Phys. Lett., A;* **58**: No. 6, 395-396(4 Oct 1976).

Propagation of circularly polarized waves along a spatially uniform but temporally fluctuating magnetic field is considered. It is shown that the coherent waves are damped. The results are compared with those for Krook's relaxation model.

THERMONUCLEAR POWER PLANTS

25658 (AEOI—10) **Fusion. The future energy source.** Naraghi, M. (Atomic Energy Organization of Iran, Teheran. Nuclear Research Center). 1976. 71p. (In Iranian). (NRC—76-7). INIS.

Glossary p. 57-69.

It is proposed that Iran as a world's potential supplier of fossil fuel should participate in fusion research and gain experience in this new field. Fusion, as an ultimate source of energy in future, and the problems concerned with the fusion reactors are reviewed. Furthermore; plasma heating, magnetic and inertial confinement in a fusion reactor are discussed. A brief description of tokamak, theta pinch and magnetic mirror reactors is also included.

25659 (CONF-761107—23) **Tokamak experimental power reactor.** Stacey, W.M. Jr.; Abdou, M.A.; Bertoncini, P.J. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 21p. Dep. NTIS $3.50.

From Annual meeting of the American Society of Mechanical Engineers; New York, New York, United States of America (USA) (29 Nov 1976).

A conceptual design has been developed for a tokamak Experimental Power Reactor to operate at net electrical power conditions with a plant capacity factor of 50 percent for 10 yr. The EPR operates in a pulsed mode at a frequency of approximately 1/min, with approximately 75 percent duty cycle, is capable of producing approximately 72 MWe and requires 42 MWe. The annual tritium consumption is 16 kg. The EPR vacuum chamber is 6.25 m in major radius and 2.4 m in minor radius, is constructed of 2 cm thick stainless steel, and has 2 cm thick detachable, beryllium-coated coolant panels mounted on the interior. A 0.28 m stainless steel blanket and a shield ranging from 0.6 to 1.0 m surround the vacuum vessel. The coolant is H_2O. Sixteen niobium-titanium superconducting toroidal field coils provide a field of 10 T at the coil and 4.47 T at the plasma. Superconducting ohmic heating and equilibrium field coils provide 135 V-s to drive the plasma current. Plasma heating is accomplished by 12 neutral beam injectors which provide 60 MW. The energy transfer and storage system consists of a central superconducting storage ring, a homopolar energy storage unit, and a variety of inductor-convertors.

25660 (INIS-mf—3164) **Present state of nuclear fusion research.** Watson-Munro, C.N. (Sydney Univ. (Australia). School of Physics). Apr 1975. 12p. INIS.

A summary is given of research programs in proceeding through-out the world in nuclear fusion. A discussion is given of magnetic confinement systems which include: 1) steady state toroidal systems, 2) stellarators and related machines, 3) tokamak devices, 4) magnetic mirrors, 5) theta pinch devices. Inertial confinement system and gas blanket research is also outlined.

25661 (PPPL—1318) **Brief review of the fusion-fission hybrid reactor.** Tenney, F.H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jan 1977. Contract E(11-1)-3073. 29p. Dep. NTIS $4.00.

Much of the conceptual framework of present day fusion-fission hybrid reactors is found in the original work of the early 1950's. Present day motivations for development are quite different. The role of the hybrid reactor is discussed as well as the current activities in the development program.

25662 (UCRL—50043-1) **Mirror hybrid reactor studies: July 1975—September 1976.** Lee, J.D. (ed.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Oct 1976. Contract W-7405-ENG-48;E(04-3)-0167-PRJ-38. 80p. Dep. NTIS $5.00.

Separate abstracts were prepared for each of the 6 included papers on mirror hybrids. (MOW)

25663 (UCRL—50043-1, pp 1-24) **Mirror hybrids: a status report.** Lee, J.D.; Bender, D.J.; Moir, R.W.; Schultz, K.R. 8 Oct 1976.

In Mirror hybrid reactor studies: July 1975—September 1976.

Studies predict that neutrons produced in a D-T plasma, classically confined in a minimum B mirror field, could be used to economically produce fissile fuel. The conceptual design of such a facility is underway at LLL and GA. This facility, a mirror fusion fast fission hybrid reactor, uses a minimum extrapolation of present fusion technology to produce 2400 kg/y Pu plus 1000 MWe net from a fusion power of 500 MW. The estimated cost of producing the Pu is 55 $/g or 4.0 mills/kWhr in an LWR fuel cycle.

25664 (UCRL—50043-1, pp 25-38) **Mirror fusion-fission reactor designs.** Moir, R.W. 8 Oct 1976.

In Mirror hybrid reactor studies: July 1975—September 1976.

The mirror fusion-fission (hybrid) reactor is seen as a producer of fissile fuel (2500 kg/yr of ^{233}U or ^{239}Pu). The use of a mirror machine as the source of fusion neutrons has some very desirable features, e.g., steady-state operation, high power density, negligible impurity control problem, and relatively small and simple geometry. The low Q values (Q = P/sub fusion//P/sub injection/) of a mirror machine are largely overcome by the large energy multiplication in the blanket. Because it uses near-term fusion technologies, the hybrid itself is a near-term reactor, especially when compared to power-producing fusion reactors. The combination of the hybrid fuel producer plus present-day fission reactors constitutes a "long-term" power source just as is claimed for the breeder reactor, but with some very advantageous differences. Present cost estimates suggest that the hybrid reactor could produce Pu for about $60/g and ^{233}U for about $130/g. This paper discusses the role of hybrid reactors and compares the mirror approach with other approaches. Past and present mirror hybrid studies are reviewed. A comparison between the hybrid and fusion reactors is made; the conclusion is that hybrids are technologically less demanding in many ways except in dealing with fission wastes. Finally, the development steps that might lead to a commercial hybrid are discussed.

25665 (UCRL—50043-1, pp 73-82) **Mirror hybrid reactor optimization studies.** Bender, D.J. 8 Oct 1976.

In Mirror hybrid reactor studies: July 1975—September 1976.

A system model of the mirror hybrid reactor has been developed. The major components of the model include (1) the reactor description, (2) a capital cost analysis, (3) various fuel management schemes, and (4) an economic analysis that includes the hybrid plus its associated fission burner reactors. The results presented describe the optimization of the mirror hybrid reactor, the objective being to minimize the cost of electricity from the hybrid fission-burner reactor complex. We have examined hybrid reactors with two types of blankets, one containing natural uranium, the other thorium. The major difference between the two optimized reactors is that the uranium hybrid is a significant net electrical power producer, whereas the thorium hybrid just about breaks even on electrical power. The projected costs for fissile fuel production are approximately 50 $/g for ^{239}Pu and approximately 125 $/g for ^{233}U.

25666 **Prospects for nuclear fusion reactors.** Hunt, S.E. (Aston Univ., Birmingham, England). *Fuel;* **54**: 3-9(Jan 1975).

Several proposed fusion reactor design principles are described, and the advantages of fusion over fission processes are detailed. The basic difficulty with achieving efficient fusion would be heating ionized deuterium to a sufficient temperature (200 million K) to counteract electron radiation loss (bremsstrahlung), and containing the plasma within a stable magnetic field to prevent contact with large, cold structural material atoms. A toroidal pinch-effect container making the conducting gaseous discharge effectively the secondary of a transformer would avoid plasma contact with anode and cathode. Magnetic mirror confiners and mirrors with additional quadrupole currents to close the ends of the nonuniform confiners are also discussed, along with laser-induced fusion.

25667 **Present state of development of thermonuclear reactors in the world.** Srb, V. (Ceske Energeticke Zavody, Prague (Czechoslovakia)). *Energetika;* **26**: No. 3, 130-133(1976). (In Czech).

Two fundamental conditions are discussed of the process of thermonuclear fusion which currently represent a significant scientific and technological problem, i.e., the high temperature of thermonuclear fuels and the plasma confinement. Most current studies are based on the deuterium-tritium reaction because the reaction has the lowest ignition temperature and is least demanding as far as heating and confinement are concerned. Two basic approaches exist to the problem of plasma confinement determining two different operating modes of a thermonuclear reactor. The first on which most thermonuclear studies are concentrated involves magnetic confinement (toroidal and mirror systems), the second is characteristic of the efforts of applying lasers or high-intensity electron beams of ultra-high energy in heating. As for radioactive emissions, tritium is the only radioactive substance to be released in the normal operation of a thermonuclear power plant. Radioactive wastes with a long half-life from a D-T reactor include non-volatile products formed mainly by refractory metal structural materials of the breeding blanket which are activated by neutrons. Operating safety of the reactors have not been investigated in detail.

25668 **Multi-step chemical and radiation process for the production of gas.** (to Texas Gas Transmission Corp.). Netherlands Patent 7,601,343/A/. 10 Feb 1976. 8p. (In Dutch).

Priority 10 Feb 1975, USA; 2 figs.

The invention discloses a multi-step chemical and radiolytic process for the production of gas such as hydrogen and oxygen. A highly radiosensitive gas such as carbon dioxide is injected directly onto the reaction chamber of a fusion reactor and is molecularly dissociated to form carbon monoxide and pure oxygen when the fusion fuel is burned. The carbon monoxide is then mixed with steam at an elevated temperature to form carbon dioxide and pure hydrogen. The carbon dioxide is recycled and injected into the central reaction chamber to complete a closed-loop process for production of pure hydrogen and oxygen at the expense of water.

25669 **Fusion reactor in which the hydrogen plasma is heated, confined, and stabilized by oscillating magnetic fields in the center of a spherical or toroidal reaction vessel.** German(FRG) Patent 2,500,279/A/. 8 Jul 1976. 17p. (In German).

10 figs. Available from Dt. Patentamt, Muenchen (FRG).

The two most difficult problems in the tests for controlled nuclear fusion are heating of the plasma to fusion temperature as well as the safe confinement in a magnetic field. According to the invention, low-resistance, low-inductive, iron-free AC compression coils are provided for dealing with these two problems the coils being arranged on the reactor vessel in such a way that both effective heating and a sufficient enclosure time are possible. It is of essential importance in this connection that the coils are fed with a relatively rectangular alternating current, which is variable with respect to frequency and power.

25670 **Fusion research in California.** Lien, M. *Tek. Ukebl.;* **123**: No. 40, 4-5,7(30 Sep 1976). (In Norwegian).

A visit to Caltech's new tokamak device at Pasadena, and Lawrence Livermore's laser-induced plasma device, SHIVA, is described. The operating principles are very briefly presented and the research and development programs outlined. The SHIVA device is illustrated in two photographs, while a cutaway drawing illustrates an experimental tokamak reactor facility.

25671 Energy: the fusion solution. Kapitza, P. (AN SSSR, Moscow. Inst. Fizicheskikh Problem). *New Sci.;* **72**: No. 1022, 83(14 Oct 1976).

The difficulties which block the way to the further and wider expansion of fission reactors to solve the energy problems, are considered. To overcome the possible environmental hazards of these reactors it is suggested that island based power plants could be used. However the final answer to high power energy problems lies in producing energy by means of thermonuclear fusion of deuterium and tritium nuclei. The advantages of the process are enumerated but the main outstanding problem is that caused by the need to produce energy fluxes of sufficient power in the plasmas. The difficulties of effective energy transfer from electrons to ions in a higher temperature plasma, which forms the basis for the useful production of thermonuclear energy, are considered.

PHYSICS AND BLANKET ENGINEERING

25672 (UCRL—50043-1, pp 39-49) **Blanket design for the mirror fusion/fission hybrid reactor.** Lee, J.D. 8 Oct 1976.

In Mirror hybrid reactor studies: July 1975—September 1976.

The evolution of this particular blanket concept is described. The geometry of the mirror reactor blanket and the replacement methods are considered. The sub-module design and its thermal-hydraulic considerations are described. The nuclear model geometry and compositions are discussed. The nuclear calculational method is discussed as well as the data used. The performance of the blanket fueled with three separate types of fuel is described.

25673 (UCRL—50043-1, pp 51-59) **Reaction rates in a uranium pile surrounding a 14-MeV neutron source: calculations of the Weale experiment.** Haight, R.C.; Lee, J.D.; Maniscalco, J.A. 8 Oct 1976.

In Mirror hybrid reactor studies: July 1975—September 1976.

To validate the neutronics analysis of hybrid fusion-fission reactor blankets, calculations were made of an experiment by Weale et al., where a 14-MeV neutron source was surrounded by a natural uranium metal pile. The evaluated nuclear data libraries, ENDL and ENDF/B, were used. The calculated parameters were found to be in closer agreement for present versions of these libraries than for preceding versions; however, there were still 15 percent differences in the $^{235}U(n,f)$, and $^{238}U(n,f)$ reaction rates. The present version of ENDL gives the results that are the closest to the experimental values for these reactions. For the $^{238}U(n,\gamma)$ reaction, the calculations with the ENDF/B libraries are closer to the measured values. Both the ENDL and ENDF/B evaluations, however, fail to calculate correctly the neutron leakage or derived values for the $^{238}U(n,2n)$ and $^{238}U(n,3n)$ reaction rates. The spatial variations of the $^{235}U(n,f)$, $^{238}U(n,\gamma)$, $^{239}U(n,f)$, and $^{239}Pu(n,f)$ reaction rates show that the penetration of high-energy neutrons in the pile is better described by the calculation with ENDL, which gives a greater penetration. The effects of resonance self-shielding were investigated and found to require a much smaller correction than the differences between calculations with different data libraries.

25674 (UCRL—50043-1, pp 61-71) **Mirror hybrid reactor blanket and power conversion system conceptual design.** Schultz, K.R.; Backus, G.A.; Baxi, C.B.; Dee, J.B.; Estrine, E.A.; Rao, R.; Veca, A.R. 8 Oct 1976.

In Mirror hybrid reactor studies: July 1975—September 1976.

The conceptual design of the blanket and power conversion system for a gas-cooled mirror hybrid fusion-fission reactor is presented. The designs of the fuel, blanket module and power conversion system are based on existing gas-cooled fission reactor technology that has been developed at General Atomic Company. The uranium silicide fuel is contained in Inconel-clad rods and is cooled by helium gas. The fuel is contained in 16 spherical segment modules which surround the fusion plasma. The hot helium is used to raise steam for a conventional steam cycle turbine generator. The details of the method of support for the massive blanket modules and helium ducts remain to be determined. Nevertheless, the conceptual design appears to be technically feasible with existing gas-cooled technology. A preliminary safety analysis shows that with the development of a satisfactory method of primary coolant circuit containment and support, the hybrid reactor could be licensed under existing Nuclear Regulatory Commission regulations.

25675 Maximum neutron wall loadings in beam-driven tokamak reactors. Jassby, D.L.; Towner, H.H. (Princeton Univ., NJ). *Nucl. Technol.;* **31**: No. 2, 159-163(Nov 1976).

If a beam-driven deuterium-tritium tokamak reactor is operated at the maximum density allowed by both pressure limitation and adequate neutral-beam penetration, the 14-MeV neutron wall loading increases approximately linearly with magnetic field or vertical elongation of the plasma. With elongation = 3, B/sub tmax/ = 15 T (at the coil windings), W/sub beam/ = 200 keV, and Q = 1.0, the maximum wall loading is approximately 5 MW/m^2.

25676 Tritium diffusion in fusion reactor blankets. Mintz, J.M.; Elleman, T.S.; Verghese, K. (North Carolina State Univ., Raleigh). Contract AT(40-1)-3508. *Nucl. Technol.;* **31**: No. 2, 172-182(Nov 1976).

The steady-state diffusion of tritium in a fusion reactor blanket has been evaluated using the Los Alamos Scientific Laboratory Theta-Pinch reactor as a reference system. The purpose was to calculate the equilibrium tritium transport rate, approximate time to reach equilibrium, and tritium inventory in various regions of the reactor blanket as a function of selected blanket parameters. Values for these quantities have been tabulated for blanket conditions that appear reasonable for the reference system.

MAGNET COILS AND FIELDS

25677 (CONF-760935—53) **Conceptual design of superconducting magnet systems for the Argonne Tokamak Experimental Power Reactor.** Wang, S.T.; Turner, L.R.; Mills, F.E.; DeMichele, D.W.; Smelser, P.; Kim, S.H. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 20p. Dep. NTIS $3.50.

From 2. topical meeting on the technology of controlled nuclear fusion; Richland, Washington, United States of America (USA) (21 Sep 1976).

As an integral effort in the Argonne Tokamak Experimental Power Reactor Conceptual Design, the conceptual design of a 10-tesla, pure-tension superconducting toroidal-field (TF) coil system has been developed in sufficient detail to define a realistic design for the TF coil system that could be built based upon the current state of technology with minimum technological extrapolations. A conceptual design study on the superconducting ohmic-heating (OH) coils and the superconducting equilibrium-field (EF) coils were also completed. These conceptual designs are developed in sufficient detail with clear information on high current ac conductor design, cooling, venting provision, coil structural support and zero loss poloidal coil cryostat design. Also investigated is the EF penetration into the blanket and shield.

25678 (ORNL/TM—5632) **Structural materials for large superconducting magnets for tokamaks.** Long, C.J. (Oak Ridge National Lab., Tenn. (USA)). Dec 1976. Contract W-7405-ENG-26. 51p. Dep. NTIS $4.50.

The selection of structural materials for large superconducting magnets for tokamak-type fusion reactors is considered. The important criteria are working stress, radiation resistance, electromagnetic interaction, and general feasibility. The most advantageous materials appear to be face-centered-cubic alloys in the Fe-Ni-Cr system, but high-modulus composites may be necessary where severe pulsed magnetic fields are present. Special-purpose structural materials are considered briefly.

25679 Superconducting field displacement loops or vessels for the compression, acceleration or confinement of hydrogen plasmas and their application in fusion reactors and particle accelerators. German(FRG) Patent 2,420,231/A/. 6 Nov 1975. 19p. (In German). 40 figs.

Superconducting field displacement loop or vessel for the compression, acceleration or confinement of hot plasmas, particularly hydrogen plasmas, in fusion reactors as well as for particle acceleration, characterized in that the field displacement loop or the field displacement vessel is designed in such a way that the magnetic field to be displaced is displaced in the direction of the loop or coil axis and hence is compressed when superconductivity occurs.

25680 Skin effect and its relaxation in tokamak LT-3. Hutchinson, I.H.; Morton, A.H. (Australian National Univ., Canberra. Dept. of Engineering Physics; Australian National Univ., Canberra. Research School of Physical Sciences). *Nucl. Fusion;* **16**: No. 3, 447-456(1976).

A hollow current profile is observed to form in the early stages of the Canberra tokamak LT-3. A helical perturbation appears, of the mode predicted by resistive MHD theory (m=4, n=1) for the measured q-profile. Subsequently, the plasma relaxes rapidly to a state of approximately uniform current. Runaway electrons diffuse very rapidly during this period with step sizes round the torus of up to 1 cm. These are indicative of a disruption of the magnetic surfaces, probably as a result of the growth of the helical perturbation.

25681 Non-circular cross-section stellarators. Shohet, J.L.; Anderson, D.T. (Wisconsin Univ., Madison (USA)); Tataronis, J.A. (New York Univ., N.Y. (USA)). *Nucl. Fusion;* **16**: No. 3, 441-445(1976).

The magnetic surfaces and rotational transform of a stellarator with low poloidal-field wave number and elliptical minor cross-section have been computed numerically by utilizing a predictor-corrector code. The surfaces exhibit stagnation points the positions of which are related to the aspect ratio of the ellipse and the l-number of the configuration. The rotational transform is less than in an equivalent stellarator with circular cross-section for the same toroidal and helical currents in the magnet coils.

25682 **Experiments on the current rise stages of the LT-3 tokamak.** Strachan, J.D. (Australian National Univ., Canberra). *Nucl. Fusion;* **16**: No. 3, 433-439(1976).

Measurement of the plasma parameters during the first two milliseconds (Isub(phi)<10 kA) of the LT-3 discharge indicates that the plasma passes through three distinctive phases. The first phase is a low-βsub(theta) phase during which the electron density is small. The second phase is ionization phase which often features hollow current profiles. The third phase is an impurity-influx phase which closely follows the completion of the hydrogen ionization. It is found that inclusion of some Z- and theta-pinching during these stages would produce hotter discharges. However, Z-pinching often induces extra impurity influx and theta-pinching reduces the current channel significantly. The theta-pinching often causes sudden partial filling of the hollow current channel, accompanied by positive voltage spikes.

POWER SUPPLIES AND CIRCUITRY

25683 (SAND—76-0674) **Self-limiting current for magnetically insulated coaxial vacuum transmission lines.** Bergeron, K.D. (Sandia Labs., Albuquerque, N.Mex. (USA)). Nov 1976. Contract E(29-1)-789. 17p. Dep. NTIS $3.50.

Existing cold fluid theories for magnetic insulation are analyzed and applied to the transmission line configuration. The relevance of these results to the propagating short pulse problem, and to DC operation, are discussed.

COOLING SYSTEMS

REFER ALSO TO CITATION(S) 25674

FUEL SYSTEMS

REFER ALSO TO CITATION(S) 25694

25684 (SAND—76-8235) **Development of glasses for application as laser fusion targets.** Shelby, J.E. (Sandia Labs., Livermore, Calif. (USA)). Jan 1977. Contract EY-76-C-04-0789. 24p. Dep. NTIS $3.50.

The development of laser fusion is highly dependent upon the concurrent development of suitable DT-filled targets. Current programs use hollow glass microspheres as containers for DT gas. The present study was to develop improved materials for the production of these glass microspheres. Results of this study indicate that lithium aluminoborate, aluminosilicate, and borosilicate glasses (in that order of preference) may be used for such applications.

25685 **Production of high-current, low-energy ion beams.** Kiyama, H. *Electr. Eng. Jpn. (Engl. Transl.);* **95**: No. 4, 1-7(1975).

Translated from Denki Gakkai Ronbunshi, A; 95: No. 7, 261-268(Jul 1975).

A low-energy, large-current ion beam was produced. The hydrogen plasma of $10^{12}/cm^3$ and the argon plasma of $10^{13}/cm^3$ were produced in a glow discharge. The ion beam was withdrawn through a multiaperture electrode with 400 apertures. The low-energy ion acceleration was very efficient at the value of γ/d larger than 0.4, which was obtained by the calculation for 20 eV energy. The low-energy ion beam diverges at high plasma density and the ion current decreases. The maximum effective current is 135 mA, energy is 500 to 1000 eV, the beam diameter is 4 cm and the effective ion efficiency is 85 to 90 percent for hydrogen plasma. The maximum effective current is 160 mA, energy is 500 eV, the beam diameter is 4 cm, the efficiency is 80 to 90 percent and the propulsion is 300 mg for argon plasma. (MOW)

25686 **Relativistic electron beam device.** Freeman, J.R.; Poukey, J.W.; Lynn, Steven; Yonas, Gerold. (to Energy Research and Development Administration). French Patent 2,275,112/A/. 11 Jun 1975. 19p. (In French).

Available from Institut National de la Propriete Industrielle, Paris (France); priority claim: 11 Jun 1974, US.

The invention relates to an electron-beam device for irradiating spherical targets carrying a hydrogen isotope. This device comprises hollow cathodes directed towards each other, a device for injecting an anodic plasma along a plane between the cathodes, and a device for generating pulses of about 1 mega-joule, between said plasma and the cathodes, every tenth microsecond. Targets are repeatedly positioned in the anodic plasma between the cathodes, and the arrangement of the accelerating diodes allows neighboring materials to withstand the repeated operation, as is necessary in a fusion energy source. This can be applied to thermonuclear fusion power stations.

RADIATION HAZARDS

25687 (CONF-750989—P3, pp 507-518) **Method for recovery of tritium from fusion plasma by rsdio frequency preferential plugging.** Miyahara, A.; Kawasaki, S.; Sato, T. (Kanazawa Univ., Japan). Mar 1976.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (30 Sep 1975).

In Radiation effects and tritium technology for fusion reactors.

For toroidal fusion reactor, fuel recovery, especially tritium recovery, is very important because fractional burn up is low and breeding rate at blanket is approximately one. When fusion plasma is exhausted through cusp field with rf plug, which is located between reactor core and pumping system, D^+, T^+, He^+ and impurity ions are separated by means of preferential plugging. Preliminary experiment has been carried out successfully for H^+, H_2i and H_3i plasma.

25688 (CONF-750989—P3, pp 519-538) **Recent experimental engineering studies related to controlled thermonuclear reactors.** Clinton, S.D.; Fisher, P.W.; Smith, F.J.; Talbot, J.B.; Watson, J.S. (Oak Ridge National Lab., TN). Mar 1976.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (30 Sep 1975).

In Radiation effects and tritium technology for fusion reactors.

Recent experimental engineering studies at ORNL on tritium handling systems for controlled thermonuclear reactors (CTRs) include investigations of: (1) metal sorbers for removal of tritium from liquid metals, (2) tritium solubility in lithium—bismuth (Li—Bi), (3) oxidation of hydrogen permeating a metal surface, and (4) cryosorption pumping of hydrogen. A yttrium metal sorber has shown significant tritium removal rates from molten potassium. The tritium sorption mass transfer coefficient was measured to be 3.0×10^{-2} cm/hr at 300°C and 1.5×10^{-1} cm/hr at 400°C. The slow mass transfer rate would dictate a large metal sorber system for tritium recovery; however, the results are encouraging enough to merit further sorbent studies with tritiated lithium. At 600°C the tritium solubility in Li—Bi (15 at. % Li) ranged from 10^{-3} to 10^{-1} torr. Due to the low solubility, further experimentation with Li—Bi as a possible extractant for tritium does not appear to be justified at the present.

25689 (CONF-760935—54) **Tritium processing and containment technology for fusion reactors: perspective and status.** Maroni, V.A. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 24p. Dep. NTIS $3.50.

From 2. topical meeting on the technology of controlled nuclear fusion; Richland, Washington, United States of America (USA) (21 Sep 1976).

This paper reviews the status of selected tritium processing and containment technologies that will be required to support the development of the fusion energy program. Considered in order are the fuel conditioning and recycle systems, the containment and cleanup systems, the blanket processing systems, and two unique problems relating to tritium interactions in neutral beam injectors and first wall coolant circuits. The major technical problem areas appear to lie in the development of (1) high-capacity, rapid recycle plasma chamber evacuation systems; (2) large-capacity (greater than or equal to 100,000 cfm) air handling and processing systems for atmospheric detritiation; (3) tritium recovery technology for liquid lithium blanket concepts; (4) tritium compatible neutral injector systems; and (5) an overall approach to tritium handling and containment that guarantees near zero release to the environment at a bearable cost.

25690 **Radiation limits to tokamak operation.** Gibson, A. (UKAEA Research Group, Abingdon. Culham Lab.). *Nucl. Fusion;* **16**: No. 3, 546-550(1976).

Letter-to-the-editor.

INERTIAL CONFINEMENT SYSTEMS

REFER ALSO TO CITATION(S) 25192, 25198, 25602, 25614, 25670

25691 (CEA-R—4721) **Interaction of a plasma laser with a Focus discharge.** Holstein, P.A. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France); Paris-11 Univ., 91 - Orsay (France)). Apr 1976. 100p. (In French). INIS.

Thesis.

The matter of the Polcus experiment is the interaction between a laser created plasma and the current sheath which is pinched during the Focus discharge. The features of the laser are the wavelength lambda=1.06μ and the full width at half maximum Δt=30ns. The Focus capacitor energy amounts to 15kJ. The discharge needs some deuterium gas which is introduced by a fast electrovalve: this way of operating Focus gave more neutrons because of the breakdown conditions. A Jamin interferometer allowed to study the interaction of both plasmas and particularly to draw the density map. The laser beam is focused onto a solid

deuterium target: if the laser energy is lower than 10J, the plasma does not disturb the Focus pinch, but does not improve the yield of neutrons. The assumption suggested by MOROZOV theory on plasma flows - to feed the Focus plasma column by the laser plasma - does not seem verified in Focus experiments for which the time of the column is very short (about 50ns).

25692 (LA—6510-PR, pp 10-55) **CO_2 laser program.** Nov 1976.

In Laser fusion program at LASL. Progress report, January 1—June 30, 1976.

The research and development programs on high-energy short-pulse CO_2 lasers were begun at LASL in 1969. Three large systems are now either operating or are being installed. The Single-Beam System (SBS), a four-stage prototype, was designed in 1971 and has been in operation since 1973 with an output energy of 250 J in a 1-ns pulse with an on-target intensity of 7.0×10^{14} W/cm^2. Target experimentation has begun on the Two-Beam System (TBS), which will ultimately generate pulses of 2 to 4 TW for target-irradiation experiments. Construction is under way on all subsystems of the Eight-Beam System (EBS), which is scheduled for completion in early 1977 and will begin target experiments at 10 to 20 TW in 1978. A fourth system, the High-Energy Gas Laser Facility (HEGLF), is in the design and prototype stage. This system will generate laser pulses of 100 to 200 TW.

25693 (LA—6510-PR, pp 75-92) **Laser fusion: theory, experiments, and target design.** Nov 1976.

In Laser fusion program at LASL. Progress report, January 1—June 30, 1976.

In an integrated program of theory, target experiments, and target design, we are establishing a fundamental understanding of laser-target interactions, particularly of the relevant plasma physics and hydrodynamics. Both the experimental and the theoretical efforts have concentrated on studying the wavelength-dependence of laser-plasma interactions. The close coupling of theory and experiment has made it possible to eliminate theories that are not supported by experiment. In general, basic studies of laser-plasma interactions have shown that the design difficulties associated with long wavelengths are less severe than believed earlier, and that breakeven target designs are attainable even in the presence of a hot-electron spectrum. These results have given us new confidence that significant yield can be obtained from more efficient, less expensive CO_2 lasers.

25694 (LA—6510-PR, pp 93-100) **Laser-fusion target fabrication.** Nov 1976.

In Laser fusion program at LASL. Progress report, January 1—June 30, 1976.

This pellet fabrication effort, supported by extensive theoretical investigations, supplies the thermonuclear fuel in packaged form suitable for laser-driven compressional heating experiments. These targets range from simple deuterated-tritiated plastic films to frozen DT pellets to complex DT gas-filled hollow microballoons, mounted on ultrathin supports and coated with various metals and/or plastics. Numerous quality-control and nondestructive testing techniques for characterizing the finished pellets are being developed.

25695 (LA—6510-PR, pp 101-110) **Target diagnostics.** Nov 1976.

In Laser fusion program at LASL. Progress report, January 1—June 30, 1976.

The tiny volume and brief duration involved in the laser-fusion process create needs for new diagnostic techniques having spatial and temporal resolutions in the submicrometer and 1- to 100-ps regime, respectively. These needs are being met with a vigorous program of diagnostics in such areas as laser calorimetry, charged particle and neutron detection, x-ray spectrometry, and subnanosecond streak-camera development.

25696 (LA—6510-PR, pp 111-123) **Applications of laser fusion: feasibility and systems studies.** Nov 1976.

In Laser fusion program at LASL. Progress report, January 1—June 30, 1976.

Feasibility and systems studies are being performed to analyze the technical feasibility and economic aspects of various commercial and military applications of laser fusion. The direct production of electricity in central-station power plants is of major concern. The general objectives of these studies are: the conceptualization and preliminary engineering assessment of laser-fusion reactors and generating stations; the development of parametric computer models of power-plant subsystems for economic and technology tradeoff and comparison studies; and the identification of problems requiring long-term development efforts. Applications of laser fusion in the production of fuel for fission reactors, the production of synthetic fuels such as hydrogen, and as a source of high-temperature process heat are also being investigated.

25697 (NRL-MR—3365) **High energy ion analyzer for laser-produced plasma studies.** Decoste, R.; Ripin, B.H. (Naval Research Lab., Washington, D.C. (USA)). Nov 1976. 24p. Dep. NTIS $3.50.

A simple electrostatic deflection multi-channel time-of-flight ion analyzer optimized to study high energy ion species from laser-produced plasmas is described. For this application moderate species and energy resolution over a wide dynamic energy range is desirable. A dynamic energy range from 1 to 1000 keV per unit charge is achieved with a 20 kV power supply. Design considerations are presented together with some typical experimental results.

25698 **Dynamic structural problems in laser fusion facilities.** Ellesmere-Jones, P. (Norman Engineering Co., Los Angeles, Calif. (USA)). pp v.2 p.E4/10 of In Structural mechanics in reactor technology. Jaeger, T.A. (comp.) (Bundesanstalt fuer Materialpruefung, Berlin (Germany, F.R.)). Amsterdam, The Netherlands; North-Holland (1975).

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

Published in summary form only.

25699 (SAND—77-6001) **Return current amplification effect upon interaction of an intense relativistic electron beam with a gas target.** Gosteva, T.S.; Dubovoi, L.V.; Zablotskaya, G.R.; Ivanov, B.A.; Chernobrovin, V.I. (Nauchno-Issledovatel'skij Inst. Ehlektrofizicheskoj Apparatury, Leningrad (USSR)). 1976. Translation by P. Newman of Preprint K-0263. 13p. Dep. NTIS $3.50.

Experiments on injection of a 1.5 MeV, 50 kA, 20 ns high-current electron beam into neutral gas are described. The conditions are found under which the amplitude of the return current induced by the primary electron beam in the plasma it creates is 2-3 times higher than the beam current. It is shown that the observed effect can be explained by beam-plasma turbulence theory and the characteristics of the equivalent electrical circuit of the experiment.

25700 **Semi-empirical estimates of neutron production in shell implosions.** Brueckner, K.A. (California Univ., San Diego, La Jolla (USA). Dept. of Physics). *Nucl. Fusion;* **16**: No. 3, 387-395(1976).

Analytic models of laser coupling, shell motion, DT-gas compression, thermal conduction, and neutron production are used to obtain relatively simple predictions of plasma conditions and neutron yield in DT-filled glass shells as functions of pellet and laser parameters. The predictions can be improved if a few parameters of the models are fixed by normalization against experiment.

25701 **Energy gain of laser-compressed pellets: a simple model calculation.** Kidder, R.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Nucl. Fusion;* **16**: No. 3, 405-408(1976).

The energy gain of laser-compressed pellets is calculated. The model used is that of a uniformly compressed pellet of DT ignited by a small, hot central "spark". Curves are presented showing the relation between energy gain and inertial confinement. Simple formulas are given that describe the least laser-pulse energy required to achieve a desired energy gain.

25702 **Range of alpha-particles in laser-produced superdense fusion plasma.** Ray, P.S.; Hora, H. (New South Wales Univ., Kensington (Australia)). *Nucl. Fusion;* **16**: No. 3, 535-536(1976).

Letter-to-the-editor.

25703 **Suppression of fast-ions from a laser-produced plasma.** Luther-Davies, B.; Hughes, J.L. (Australian National Univ., Canberra. Dept. of Engineering Physics). *Phys. Lett., A;* **58**: No. 6, 399-401(4 Oct 1976).

Fast-ion emisssion occurs when a target is irradiated with single 25 psec pulses from a Nd:YAG/glass laser but is suppressed when the same target is irradiated with a mode-locked pulse train at the same intensity. Possible explanations for this effect are given.

COMPONENT DEVELOPMENT AND TESTING

REFER ALSO TO CITATION(S) 25024, 25025, 25026, 25076

25704 (AI-ERDA—13188) **Neutron fluence map for the rotating target neutron source.** Kneff, D.W.; Farrar, H. IV.; Van Konynenburg, R.A.; Heinrich, R.R. (Atomics International Div., Canoga Park, Calif. (USA)). 31 Dec 1976. Contract E(04-3)-0701. 55p. Dep. NTIS $4.50.

Nine nickel, niobium, and gold dosimetry foils incorporated in a neutron irradiation experiment at the Rotating Target Neutron Source (RTNS) facility were analyzed to construct a three-dimensional neutron fluence map. The purpose of the map was to determine the exact neutron fluences received by several pure element specimens irradiated for helium generation studies. However, the map alone provides the most detailed profile yet obtained of the RTNS neutron fluence distribution at the highest flux region accessible for irradiation experiments. This report gives details of the map, and provides a dosimetry procedure for use in future irradiations requiring accurate fluence information. The map also provides precise relative cross sections for the Ni, Nb, and Au dosimetry reac-

tions for 14.8-MeV neutrons. The $^{58}Ni(n,p)^{58}Co$ cross section is significantly lower than the current published evaluation. An analytical expression was derived to describe the measured fluence distribution; this was compared with an existing mathematical model of the RTNS neutron fluence profile. The model was found to represent approximately the fluence profile for a range of source parameters, but it cannot be used for an accurate determination of the fluence variation in a given irradiation experiment.

25705 (CONF-761059—16) **Surface erosion phenomena in connection with CTR applications.** Kaminsky, M.; Das, S.K. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 9p. Dep. NTIS $3.50.

From 4. annual conference on the use of small accelerators; Denton, Texas, United States of America (USA) (25 Oct 1976).

The interaction of plasma radiations with the exposed surfaces of components of plasma devices and future controlled thermonuclear fusion reactors (CTR) can cause a variety of surface effects. In turn, such surface effects can cause (a) the release of plasma contaminants, and (b) the damage and erosion of the irradiated surfaces. The contamination of the plasma can have serious effects on plasma stability and on plasma temperature, and the surface erosion can seriously limit the lifetime of the irradiated components. At present, knowledge of surface erosion rates for the plasma parameters and materials envisioned in CTR applications is only fragmentary. To what extent the erosion rates will be affected by synergistic effects due to the simultaneous bombardment of surfaces by high fluxes of energetic particles of various types and by photons is almost completely unknown. A summary of some of the major surface erosion phenomena which have been identified as being important for CTR applications by using single irradiation sources (e.g., accelerators) will be given. A discussion of some potential solutions to reduce surface erosion will be included. The main features of a recently completed two component irradiation facility at ANL for CTR related surface studies will be described.

25706 (EUR-CEA-FC—816) **Influence of the limiter material on the plasma characteristics in the Petula Tokamak.** Bardet, R.; Bernard, M.; Briffod, G.; Clement, M.; Frank, R.; Gauthier, A.; Gregoire, M.; Gruber, S.; Grelot, P.; Hesse, M. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Apr 1976. 37p. INIS.

In the PETULA Tokamak, three series of discharges were run with successively tungsten, alumina and carbon limiters. The characteristics of the plasma in these three situations are presented and compared. It is found that the lowest oxygen impurity level and lowest effective ion charge were obtained with the alumina limiter. With this limiter the plasma energy confinement time is 50% higher than that found for the tungsten limiter. During a rather short period the machine was operated with a carbon limiter which led to very resistive discharges and the appearance of disruptive instabilities related to a plasma-limiter interaction. From a technological point of view the alumina limiter was appreciably damaged after about a thousand discharges whereas the carbon one appeared to perfectly withstand thermal stresses.

25707 (HEDL-TME—76-83) **Magnetic fusion energy. Progress report, January—June 1976.** Doran, D.G.; Yoshikawa, H.H. (comps.). (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1976. Contract E(45-1)-2170. 22p. Dep. NTIS $4.00.

Brief descriptions are given of progress in the Irradiation Effects Analysis and Mechanical Performance of Magnetic Fusion Energy (MFE) Materials programs and in related programs. The objective of the Irradiation Effects Analysis program is the correlation of effects produced in neutron and charged particle irradiations in order to apply them to fusion reactor environments. Low energy displacement cascades—of intrinsic interest and the least understood component of high energy cascades—are being simulated by computer codes of the dynamical (D), quasi-dynamical (Q-D), and binary collision (BC) types. Fair agreement has been found between D and Q-D for low index focused replacement sequences; substantial differences appeared for a 250 eV high index event. The objective of the Mechanical Performance of MFE Materials program is to establish the effects of fusion reactor irradiation environments on the mechanical properties of candidate first wall materials. A Precision Torsional Creep Apparatus is being developed to permit accelerator studies of irradiation creep and behavior under cyclic conditions. This apparatus has demonstrated the required strain sensitivity, stress control, and thermal stability for long term thermal testing, and that it can be used for cyclic testing.

GENERAL AND MISCELLANEOUS

25708 (JPRS—68348) **Translations on People's Republic of China.** 10 Dec 1976. Translation of People's Republic of China, No. 367. vp. NTIS.

The report contains political, sociological, economic, government, scientific and technological information on China: motor vehicle manufacture, machine industry of a city, building materials, chemical fertilizers, various industries, oil exploration under river deltas, contents of a zoology magazine. (DLC)

MANAGEMENT

REFER ALSO TO CITATION(S) 25484

25709 (ERDA—76-41(11-76)) **ERDA headquarters reports: November 1976.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Administrative Services). Nov 1976. 68p. Dep. NTIS $4.50.

ERDA Headquarters reports (ERDA-76-41) provides a cumulative record through various lists and an index of the reports issued from ERDA Headquarters. The four sections of this publication are as follows: new ERDA reports, list of Headquarters reports received in the ERDA Library during the past month; cumulative list of ERDA reports, all ERDA (Hq) reports already issued or scheduled to be issued; reports by program division, separate lists of ERDA reports arranged by the division or office at ERDA Headquarters responsible for their preparation and/or issuance; and index to keywords in report titles, an index to keywords in the report titles.

25710 (SAND—76-0413) **Sandia Laboratories technical capabilities: design, definition, and fabrication.** (Sandia Labs., Albuquerque, N.Mex. (USA)). Dec 1976. Contract E(29-1)-789. 25p. Dep. NTIS $3.50.

This report characterizes the design definition and fabrication capabilities at Sandia Laboratories. Selected applications of these capabilities are presented to illustrate the extent to which they can be applied in research and development programs. 13 figures.

25711 (UCRL—50028-76-3) **H-Division quarterly report, July—September 1976.** (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Nov 1976. Contract W-7405-ENG-48. 59p. Dep. NTIS $4.50.

Brief descriptions are given of the current work of the Theoretical Equation of State (EOS), Experimental Physics, Code Development, Fluid Mechanics, and Solid Mechanics groups. Among the projects underway at this time are the following: construction of a two-phase EOS for water to be used in reactor safety calculations; isobaric expansion experiments on glassy carbon and lithium to clarify thermodynamic properties; determination of the high-temperature yield strength of hallow tantalum tubes; study of the melting transition of Al; influence of EOS fluctuations on thermodynamic processes; fundamental study of crack initiation and propagation of application to pressure vessels; photographic diagnostics for uniaxial tension test of A533 steel specimen; and studies in fracture mechanics. 45 figures, 2 tables. (RWR)

25712 (UCRL—52000-76-11) **Energy and technology review.** Selden, R.W. (ed.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). Nov 1976. Contract W-7405-ENG-48. 17p. Dep. NTIS $3.50.

A separate abstract was prepared for each of the three articles in this issue. (RWR)

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 25600, 25604

25713 (BNL—20425) **Techniques of three-dimensional reconstruction. Proceedings of an international workshop, Upton, New York, July 16—19, 1974.** Marr, R.B. (ed.). (Brookhaven National Lab., Upton, N.Y. (USA)). 1974. Contract E(30-1)-16;NSF-G-AG-503. 172p. (CONF-740779—). Dep. NTIS $6.75.

From International workshop on three-dimensional image reconstruction techniques; Upton, New York, United States of America (USA) (16 Jul 1974).

Forty-two short papers representing a wide variety of scientific disciplines but with a common interest on the problem of reconstructing functions in three dimensional space from their projections along various directions onto planes are included. The problem of three-dimensional image reconstruction is of interest in areas such as nuclear medicine, electron microscopy, radio astronomy, holographic interferometry, plasma physics, and radiography. (WHK)

25714 (COO—2383-0033) **Graphics one terminal design and user's manual.** Artwick, B.A.; Whaley, A.D. (Illinois Univ., Urbana (USA). Dept. of Computer Science). Jul 1976. Contract E(11-1)-2383. 72p. (UIUCDCS-R—76-814). Dep. NTIS $4.50.

A graphics terminal using raster scan on an ordinary TV monitor is described. The scan is done out of a bank of 4K dynamic RAMS which are set or reset asynchronously by an independent microprocessor. Special features are the microprocessor (built out of ordinary 7400 series parts) which does all graphics, text, and communications and the method for storing the raster image in RAMS. 23 figures.

25715 (COO—2383-0034) **Algorithms for sparse Gaussian elimination with partial pivoting.** Sherman, A.H. (Illinois Univ., Urbana (USA). Dept. of Computer Science). Jul 1976. Contract EY-76-S-02-2383. 21p. Dep. NTIS $3.50.

Several algorithms for sparse Gaussian elimination are compared with column interchanges. The algorithms are all derived from the same basic elimination scheme, and they differ mainly in implementation details. Their theoretical behavior is examined and their performances on a number of test problems is compared with that of a high quality complete threshold pivoting code. The conclusion is that partial pivoting codes perform quite well and that they should be considered for sparse problems whenever pivoting for numerical stability is required.

25716 (LA—6627-MS) **ESECT/EMAP: mapping algorithm for computing intersection volumes of overlaid meshes in cylindrical geometry.** Wienke, B.R.; O'Dell, R.D. (Los Alamos Scientific Lab., N.Mex. (USA)). Dec 1976. Contract W-7405-ENG-36. 27p. Dep. NTIS $4.00.

ESECT and EMAP are subroutines which provide a computer algorithm for mapping arbitrary meshes onto rectangular meshes in cylindrical (r,z) geometry. Input consists of the lines defining the rectangular mesh and the coordinates of the arbitrary mesh, which are assumed to be joined by straight lines. Output consists of the intersection volumes with designation of common mesh zones. The ESECT and EMAP routines do not comprise a "free-standing" code but, instead, are intended for inclusion in existing codes for which one mesh structure (typically Lagrangian) needs to be mapped onto an Eulerian mesh. Such mappings are of interest in coupled hydrodynamic and neutronic calculations. Exact expressions for the volumes of rotation (about z-axis) generated by the planar mesh intersection areas are used. Intersection points of the two meshes are computed and mapped onto corresponding regions on the rectangular mesh. Intersection points with the same regional indices are recorded into multilaterals, and the multilaterals are triangulated to facilitate computation of the intersection volumes. Dimension statements within ESECT/EMAP presently allow for rectangular and arbitrary meshes of 10k and 3.6k grid points. Scaling of all arrays to suit individual applications is easily effected. Computations of intersection volumes generated by overlapping 10k rectangular and 2.2k radial meshes require an average of 18 s computer time, while computation times for the same meshes scaled by a factor of ¼ in number of grid points average 3 s on the CDC 7600. Generally, cases of small cell rectangular meshes overlaid on large cell arbitrary meshes require the longer running times. 10 figures, 2 tables.

25717 (LA-UR—76-2375) **Symbiont system for intercomputer communication using shared memory.** Poore, R.V.; Sunier, J.W.; McMillan, D.E. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976. Contract W-7405-eng-36. 15p. (CONF-761203—1). Dep. NTIS $3.50.

From 2. annual MUSE meeting; Ft. Lauderdale, Florida, United States of America (USA) (6 Dec 1976).

Group P-9 at the Los Alamos Scientific Laboratory has three MODCOMP IV/25 computers. The configuration consists of a host computer and two satellite computers. It was decided to implement an intercommunication system using the shared memory feature of the system and symbionts. With this symbiont approach all MAX IV file I/O operations using REX services are supported. The operation of this system is described in some detail. Among the topics covered are system initialization, common block structure, resources of the tasks, error conditions, limitations, and speed. 6 figures. (RWR)

25718 (ORNL/CSD—18(Suppl.1)) **KWIC index for numerical algebra.** Carpenter, J.A. (Oak Ridge National Lab., Tenn. (USA)). Dec 1976. Contract W-7405-ENG-26. 136p. Dep. NTIS $6.00.

This listing is a supplement to Professor A. S. Householder's KWIC Index for Numerical Algebra, ORNL-4778, Revised June 1975. Corrections and additional review journal citations for ORNL-4778, Revised, are not included in this supplement, which lists 1325 new entries of interest to those working in this branch of numerical analysis.

25719 (ORNL/TM—5719) **Fast exponential calculation for the IBM 370-195 at the Oak Ridge Gaseous Diffusion Plant.** Whitson, J.C.; Whealton, J.H. (Oak Ridge National Lab., Tenn. (USA)). Jan 1977. Contract W-7405-ENG-26. 7p. Dep. NTIS $3.50.

The time spent for computing an exponential for the IBM 370-195 at the Oak Ridge Gaseous Diffusion Plant is about 25 times slower than that spent by the CDC-7600 CTR computer at Livermore. We propose a scheme which does not involve a function call, is 15 times faster than the IBM 370-195 scheme, and is useful when the exponential is called many times.

25720 (SAND—76-0585) **Practical solution of ordinary differential equations by Runge—Kutta methods.** Shampine, L.F.; Watts, H.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). Dec 1976. Contract E(29-1)-789. 106p. Dep. NTIS $5.50.

All those factors bearing on the creation of a high-quality Runge—Kutta code for the solution of ordinary differential equations are studied. These include the selection of a formula based on many theoretical and experimental measures of quality; the various aspects of constructing efficient, reliable algorithms; and the design of convenient but flexible software. A code, RKF45, is presented as a concrete realization of the conclusions of the study. 29 tables.

25721 (SAND—76-0631) **Comparison of several rank tests for the two-way layout.** Iman, R.L.; Conover, W.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). Dec 1976. Contract E(29-1)-789. 53p. (CONF-760862—2). Dep. NTIS $4.50.

From Annual meeting of the American Statistical Association; Boston, Massachusetts, United States of America (USA) (23 Aug 1976).

There are several rank tests for analyzing certain experimental designs. This study compares the robustness and power of several of these, including the rank transform, aligned ranks, and joint rank sum procedures. The experimental designs studied include the two-way layout with $n = 2$ and $n = 5$ observations per cell, the two-way layout with unequal numbers of observations per cell, and the two-way layout with replication. Results are obtained by Monte Carlo simulation of normal, lognormal, and exponential random variables, using linear and nonlinear models. The results show the rank transform procedures to be superior to the other rank tests on the basis of robustness, power, and ease of application. They appear to be preferable to the usual analysis of variance procedures, except where the usual analysis of variance assumptions are met. 32 figures, 9 tables.

25722 (SAND—77-0023) **Initial step for an ODE solver.** Shampine, L.F. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jan 1977. Contract E(29-1)-789. 9p. Dep. NTIS $3.50.

Every code for solving ordinary differential equations (ODE's) in a step-by-step manner must somehow obtain an initial step size. This step is a critical one because it is relatively easy for the code to select subsequent step sizes. Supplying an initial step size is an annoyance for the user at best, and it may result in an exceedingly bad value when the user does not know how to proceed. Problems with some previous methods for determining initial steps are discussed, and a new scheme is described which does not share earlier difficulties. (RWR)

25723 (TREE—1012) **SRTPRN: a program to sort and prune fault tree cut sets.** Dolan, C.A. (EG and G Idaho, Inc., Idaho Falls (USA)). Dec 1976. Contract EY-76-C-07-1570. 61p. Dep. NTIS $4.50.

SRTPRN is a computer program which sorts fault tree cut sets into groups according to their importance. If desired, it also discards groups of unimportant cut sets and thus prunes the fault tree they represent. The program output includes an ordered list of cut sets retained, a list of the components or failure events represented in these cut sets, and a list of the cut sets deleted, if any. 14 figures, 6 tables.

25724 (UCID—17352) **User's guide to SURFACE: an interactive program for creating pictures and movies of three-dimensional surfaces.** Chappell, G.A.; Cox, L.A. Jr. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Dec 1976. Contract W-7405-ENG-48. 28p. Dep. NTIS $4.00.

In many cases, scientifically important problems cannot be well represented for visual interpretation in two dimensions. For example, in the case of potential energy surfaces, two-dimensional plots are often insufficient. Additionally, the available data in these problems tends to be rather sparse—at least by computer graphics standards. SURFACE is a computer code designed to operate with Livermore Time Sharing System hardware and software. The program's purpose is to facilitate comprehensive analysis through the generation of three-dimensional figures from sparse data sets and the production of a 16- or 35-mm movie of the surface from a wide range of perspectives. 10 figures.

25725 (UCID—30150) **Solution of block-tridiagonal systems of linear algebraic equations.** Hindmarsh, A.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Feb 1977. Contract W-7405-ENG-48. 28p. Dep. NTIS $4.00.

The solution of linear systems with a block-tridiagonal structure is a very common requirement in many applications. This report

describes two Fortran packages for solving such systems. The first is for the case when all the relevant blocks in the coefficient matrix can be stored at once. The second is for the case when they cannot; instead the equations are generated, one block-row at a time, by a user-supplied subroutine. The blocks are assumed to be full, and partial pivoting is done within block-rows only.

25726 (UCRL—52000-76-11, pp 6-10) **Recognizing the pattern of crime.** Cox, L.A. Jr. Nov 1976.

In Energy and technology review.

Under ERDA's technology utilization program, LLL is helping the San Diego Police Department explore the usefulness of automated crime analysis. Through use of an LLL computer code, it was demonstrated experimentally that computer pattern recognition is a feasible method for analyzing crime. There now remains completion of the technology transfer cycle by assisting in the transition from the experimental system to an operational one. Then, the San Diego police can use it as a time-saving, cost-effective tool for allocating the department's available manpower more effectively to solve and prevent crime. 1 figure, 2 tables.

25727 (UCRL—78748) **Application of microprocessors in a national laboratory.** Fisher, E.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Oct 1976. Contract W-7405-eng-48. 8p. (CONF-761006—25). Dep. NTIS $3.50.

From Nuclear science, scintillation and semiconductor counter symposium; New Orleans, Louisiana, United States of America (USA) (20 Oct 1976).

The involvement of Lawrence Livermore Laboratory with microcomputer technology began in 1972, when the Intel 8008 microprocessor was selected as the basis for a standard system within the Laboratory. The implementation of the microprocessor standard is reviewed; a logic module line that was currently in use in minicomputer automation was considered the best route for expansion. The flexibility of the modular approach is demonstrated by its ability to stay up with current technology. Various areas of application of a modular microcomputer system discussed include the floppy disk, the general-purpose interface buss, and high-level language. 7 figures. (RWR)

25728 **Finite-difference approximations and entropy conditions for shocks.** Harten, A.; Hyman, J.M.; Lax, P.D. Contract E(11-1)-3077. *Commun. Pure Appl. Math.;* **29**: 297-322(1976).

Weak solutions of hyperbolic conservation laws are not uniquely determined by their initial values; an entropy condition is needed to pick out the physically relevant solution. The question arises whether finite-difference approximations converge to this particular solution. It is shown that, in the case of a single conservation law, monotone schemes, when convergent, always converge to the physically relevant solution. Numerical examples show that this is not always the case with nonmonotone schemes, such as the Lax—Wendroff scheme. 4 figures, 2 tables

25729 **Introduction to microcomputers.** Paretti, C. (CNEN, Casaccia, Italy). *Com. Naz. Energ. Nucl., Not.;* **22**: No. 2, 25-31(Feb 1976). (In Italian).

The firmware technique is introduced to the designer of logic circuits. Features of microprocessor, microcomputer systems on the market and advantages of these components are discussed. Some experiments done at the Instrumentation Laboratory of the Casaccia Center are briefly described as examples. 5 figures.

25730 **System evaluation.** Barton, G.W. Jr. (Univ. of California, Livermore). *ASTM Stand. News;* **5**: No. 11, 23-26(May 1976).

An evaluation of computerized laboratory systems asks three questions: Does the system meet the needs. Does it have unused potential. Is there any way it can be done better next time. Several interfaces must be considered: computer—instrument, operator—instrument, and operator—computer. All the components must work together successfully. The reactions of both the operator and the data user are important; management reaction can't be overlooked, either. The transition to a computerized system must be orderly, and give the same answers as the old manual approach. Finally, the system must be adequately documented. This paper is not technical in nature. (RWR)

INFORMATION HANDLING

REFER ALSO TO CITATION(S) 24864

25731 (ORNL/EIS—98) **Environmental/Biomedical Terminology Index.** Huffstetler, J.K.; Dailey, N.S.; Rickert, L.W.; Chilton, B.D. (Oak Ridge National Lab., Tenn. (USA)). Dec 1976. Contract W-7405-ENG-26. 662p. Dep. NTIS $16.25.

The Information Center Complex (ICC), a centrally administered group of information centers, provides information support to environmental and biomedical research groups and others within and outside Oak Ridge National Laboratory. In-house data base building and development of specialized document collections are important elements of the ongoing activities of these centers. ICC groups must be concerned with language which will adequately classify and insure retrievability of document records. Language control problems are compounded when the complexity of modern scientific problem solving demands an interdisciplinary approach. Although there are several word lists, indexes, and thesauri specific to various scientific disciplines usually grouped as Environmental Sciences, no single generally recognized authority can be used as a guide to the terminology of all environmental science. If biomedical terminology for the description of research on environmental effects is also needed, the problem becomes even more complex. The building of a word list which can be used as a general guide to the environmental/biomedical sciences has been a continuing activity of the Information Center Complex. This activity resulted in the publication of the Environmental Biomedical Terminology Index (EBTI).

25732 **Biogeographic information system for animal species in the southeastern United States.** Kitchings, T.; Anderson, S.; Olson, R.J. (Oak Ridge National Lab., TN). *ASB (Assoc. Southeast. Biol.) Bull.;* **23**: No. 3, 149-154(Jul 1976).

Information stored in our data bank can be used in identifying characteristics of the habitat which, if altered, might affect rare and endangered species. This analysis provides information about specific variables that are important to the abundance and distribution of rare and endangered species. Presumably changes in these selected habitat variables, which include types of vegetation, openness, and distances to water, would alter the species composition in this area. With this habitat information and related population data we feel it will be possible to predict changes in the populations of animal species prior to landscape alteration over large regional areas. The type of data analysis we have demonstrated can have far-reaching effects in conservation of not only existing rare or endangered species but also of those species which may become endangered by unknowing destruction of critical elements of their habitat.

LAW

REFER ALSO TO CITATION(S) 24914

25733 **Act on the peaceful uses of atomic energy and protection against its hazards (Atomic Energy Act) Revised as of 1st October 1975.** *Nucl. Law Bull., Suppl.;* No. 15, 5-41(Apr 1975). (In English and French).

Translation of German Basic Atomic Energy Act of 23.12.1959 - latest revision.

This Act, whose purpose is to promote the development of nuclear power while ensuring that such development will not harm national security and the health and property of the population, covers all nuclear activities. It therefore supplies the legal framework applicable to imports and exports of nuclear fuels and their transport: it defines the system for licensing and control of nuclear installations; it also contains the provisions on the third party liability of operators of land-based installations and nuclear ships. This Act was amended on several occasions since its publication in 1959 and the latest revision came into force on 1st October 1975.

25734 **How to facilitate third party liability insurance for international transport of nuclear substances.** Deprimoz, J. (Pool Francais d'Assurances des Risques Atomiques, 75 - Paris). *Rev. Gen. Assur. Terr.;* **46**: No. 4, 489-509(Oct 1975). (In French).

Third party liability insurance for nuclear damage likely to be caused during international transport of nuclear substances should be approved, in accordance with the 1960 Paris Convention, by the countries over whose territories these substances are carried even when the insurer is in a foreign country. However this policy is not yet applied in all the member countries of the Convention. A solution might be to follow the international motor insurance scheme, commonly called the green card system, which guarantees the insurance taken out by the driver. In addition, the financial security certificate provided by the Paris Convention should be changed to adapt with international transport conditions.

25735 **Agreement between the Federal Republic of Germany and the Federative Republic of Brazil of 26 June 1975 on co-operation in the peaceful uses of nuclear energy.** Boulanger, W. (Bundesministerium fuer Forschung und Technologie, Bonn (F.R. Germany)). pp 231-235 of In Nuclear Inter Jura 75 Proceedings. Paris; International Nuclear Law Association (1976). (In German)

From Nuclear Inter Jura 75 Congress; Aix-en-Provence, France (29 Sep 1975).

The Agreement provides for co-operation between organizations engaged in scientific and technological research and enterprises in both States in the following: prospecting, extraction and processing of uranium ores as well as the production of uranium compounds; construction of nuclear reactors and other nuclear installa-

tions, as well as their components; uranium enrichment and enrichment services; manufacture of fuel elements and reprocessing of irradiated fuels. The Agreement is implemented by specific guidelines. In total, 8 nuclear power plants, one enrichment plant, one fuel element fabrication plant and a reprocessing plant are planned. The supply and export of nuclear materials, equipment and installations, as well as relevant technological information is subject to IAEA safeguards.

25736 Progress report on the Italian regulations governing the peaceful uses of atomic energy and their recent developments. Nocera, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). pp 238-247 of In Nuclear Inter Jura 5 Proceedings. Paris; International Nuclear Law Association (1976).

From Nuclear Inter Jura 75 Congress; Aix-en-Provence, France (29 Sep 1975).

Italian legislation in this field is based essentially on two texts; the general Act of 1962 on the peaceful uses of nuclear energy and the implementing Decree of 1964 containing the provisions relating to the safety of nuclear installations and to radiation protection. These texts are aligned on the applicable international standards, particularly on radiation protection and third party liability. Furthermore, Italian nuclear legislation has recently been completed by Acts on the siting of electricity generating plants. Finally, Italy has supported the policy on international security by ratifying the Treaty on the Non-Proliferation of Nuclear Weapons.

25737 Juridical utilization of dosimetric results. Hebert, J. (Electricite de France, 75 - Paris. Direction de l'Equipement). pp 361-375 of In Les concepts de faible dose de rayonnements ionisants en radiobiologie et en radioprotection. II. Cayet-Pennaneac'h, O. (ed.). Montrouge; Societe Francaise de Radioprotection (1976). (In French)

From 2. Seminar on radiobiology; Fontenay-aux-Roses, France (29 Apr 1975).

The problems of the legal use of the results of dosimetry, for the solution of an action for instance, are considered first with respect to civil and occasionally administrative third part liability law making a distinction between common law and the special regime of civil liability for nuclear damage, secondly with respect to social security law.

25738 Promulgation of the coming into force of the Convention relating to Civil Liability in the Field of Maritime Carriage of Nuclear Material. *Bundesgesetzblatt, Teil 2;* No. 12, 307(Feb 1976). (In German).

Short communication only.

25739 Public announcement of the agreement between the governments of the FRG and the Federative Republic of Brazil on cooperation in the field of peaceful uses of nuclear energy. *Bundesgesetzblatt, Teil 2;* No. 12, 334-336(Feb 1976). (In German).

German text of the Agreement.

25740 Promulgation of the purview of the Supplementary Convention and its Additional Protocol to the Paris Convention on Third Party Liability in the Field of Nuclear Energy. *Bundesgesetzblatt, Teil 2;* No. 47, 1468(Aug 1976). (In German).

Short communication only.

CORPORATE INDEX

In the corporate index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

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ERDA Energy Information Data Base: Corporate Author Entries (TID-4585) is used in the standardization of corporate entries. TID-4585 is available for purchase from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia 22161.

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Occupancy-use readiness manual: safety considerations, 2:25484 (ERDA—76-45-1)

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Reliability program plan for isotope Brayton Ground Demonstration System program. Phase I, 2:24139 (GE-BIPS—72-002)

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The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

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	2:24866	ASCE, 345 E. 47 St., New York, NY 10017, $10.00
CONF-751096-		(Conference on the environmental impact of water chlorination, Oak Ridge, Tennessee, United States of America (USA), 22-24 Oct 1975)
	2:25316	Dep. NTIS, $12.00
CONF-7510150-		(Energy development and environment seminar, Schiller Park, Illinois, United States of America (USA), 16 Oct 1975)
1	2:23906	Institute of Gas Technology, Chicago, IL
CONF-751140-		(Meeting on post-accident heat removal information exchange, Albuquerque, New Mexico, USA, 13-14 Nov 1975)
4	2:24739	*See* GA-A-13734
CONF-760237-		(Symposium on stimulation of low permeability reservoirs, Golden, Colorado, United States of America (USA), 16-17 Feb 1976)
	2:24001	Colorado School of Mines, Golden, CO
CONF-760310-		(IAEA symposium on the management of radioactive waste, Vienna, Austria, 22-26 Mar 1976)
18	2:24117	*See* ORNL-tr-4202
CONF-760314-		(Meeting on inservice-inspection and monitoring of LMFBRs, Bensberg, German Democratic Republic, 9-12 Mar 1976)
3	2:24427	*See* HEDL-SA-1092(Rev.1)
CONF-760354-		(Conference on capturing the sun through bioconversion, Washington, District of Columbia, United States of America (USA), 10-12 Mar 1976)
	2:24150	Washington Center for Metropolitan Studies, 1719 Massachusetts Ave., NW, Washingtn, DC (1976). $18.00
CONF-760371-		(4. cyclotron users' meeting, Miami, Florida, United States of America (USA), 25-27 Mar 1976)
2	2:25120	*See* LA-UR-76-2127
CONF-760436-		(International symposium on californium-252 utilization, Paris, France, 26-28 Apr 1976)
7	2:24141	*See* DP-MS-76-30
CONF-760585-		(International petroleum exposition and congress, Tulsa, Oklahoma, United States of America (USA), 17-21 May 1976)
1	2:23899	Inst. of Gas Technology, Chicago
CONF-760619-		(Joint international magnetism and magnetic materials intermag conference, Pittsburgh, Pennsylvania, United States of America (USA), 15-18 Jun 1976)
	2:25004	American Institute of Physics (1976).
CONF-760647-		(NEANDC/NEACRP specialists meeting on fast neutron fission cross sections of U-233, U-235, U-238, and Pu-239, Argonne, Illinois, United States of America (USA), 28-30 Jun 1976)
	2:25559	*See* ANL-76-90
CONF-760662-		(4. symposium on radiation chemistry, Keszthely, Hungary, 1-5 Jun 1976)
3	2:25162	Dep. NTIS, $3.50
4	2:25163	Dep. NTIS, $3.50
CONF-760685-		(Topical meeting on multiparticle production on nuclei at very high energy, Trieste, Italy, 10-15 Jun 1976)
1	2:25530	*See* FERMILAB-CONF-76/67-EXP
CONF-760687-		(Fermilab study of the doubler as collider, Aspen, Colorado, United States of America (USA), 28 Jun-9 Jul 1976)
2	2:25511	*See* ANL-HEP-CP-76-52
CONF-760696-		(International conference on uranium enrichment, New York, New York, United States of America (USA), 30 Jun 1976)
1	2:24058	Dep. NTIS, $3.50
CONF-760698-		(AENEC Workshop 1: plume modeling-field data interactions, Oak Ridge, Tennessee, United States of America (USA), 16-18 Jun 1976)
1	2:25297	*See* BNWL-SA-5901
CONF-7606122-		(27. annual AIBS meeting, New Orleans, Louisiana, United States of America (USA), Jun 1976)
1	2:25363	*See* COO-2502-10
CONF-7606126-		(21. symposium of the American Scientific Glassblowers Society, Chicago, Illinois, United States of America (USA), 7-11 Jun 1976)
1	2:24207	Dep. NTIS, $3.50

Report No.	Abstract No.	Availability
CONF-760719-		(18. international conference on high energy physics, Tbilisi, Union of Soviet Socialist Republics (USSR), 15-21 Jul 1976)
25	2:25529	*See* LBL-5524
CONF-760743-		(GUM meeting, Neuherberg, German, Federal Republic of (F.R. Germany), 1-2 Jul 1976)
1	2:25360	Dep. NTIS, $3.50
CONF-760744-		(Conference on energy sources of the future, Oak Ridge, Tennessee, United States of America (USA), 5-23 Jul 1976)
2	2:25445	Dep. NTIS, $3.50
CONF-760804-		(4. international conference on strength of metals and alloys, Nancy, France, 30 Aug-3 Sep 1976)
5	2:25062	*See* COO-1367-75
CONF-760829-		(Applied superconductivity conference, Stanford, California, United States of America (USA), 17-20 Aug 1976)
50	2:25005	Dep. NTIS, $3.50
CONF-760842-		(Joint conference of the American Section of the International Solar Energy Society and The Solar Energy Society of Canada, Inc.,, Winnipeg, Manitoba, Canada, 15-20 Aug 1976)
9	2:24189	Dep. NTIS, $3.50
10	2:24190	Dep. NTIS, $3.50
11	2:24191	Dep. NTIS, $3.50
12	2:24192	Dep. NTIS, $3.50
13	2:24193	Dep. NTIS, $3.50
15	2:24157	Dep. NTIS, $3.50
17	2:24206	*See* LBL-5293
18	2:24159	*See* LBL-5292
CONF-760849-		(Conference on particle physics, Stanford, California, United States of America (USA), 2-13 Aug 1976)
1	2:25509	*See* LBL-5500
CONF-760862-		(Annual meeting of the American Statistical Association, Boston, Massachusetts, United States of America (USA), 23-26 Aug 1976)
2	2:25721	*See* SAND-76-0631
CONF-760866-		(4. international electric vehicle symposium, Dusseldorf, German, Federal Republic of (F.R. Germany), 31 Aug-2 Sep 1976)
2	2:24858	Dep. NTIS, $4.00
CONF-760872-		(Symposium on the Crust, Vail, Colorado, United States of America (USA), 2-6 Aug 1976)
1	2:25487	*See* LA-UR-76-1708
CONF-760903-		(8. world conference on nondestructive testing, Cannes, France, 6-11 Sep 1976)
6	2:25222	Dep. NTIS, $3.50
CONF-760922-		(International conference on magnetism, Amsterdam, Netherlands, 6-10 Sep 1976)
14	2:25495	Dep. NTIS, $3.50
CONF-760935-		(2. topical meeting on the technology of controlled nuclear fusion, Richland, Washington, United States of America (USA), 21-23 Sep 1976)
53	2:25677	Dep. NTIS, $3.50
54	2:25689	Dep. NTIS, $3.50
CONF-760936-		(Solar energy and development symposium, Bamako, Mali, 28 Sep-2 Oct 1976)
	2:24187	Dep. NTIS, $3.50
CONF-760938-		(International conference on the applications of the Mossbauer effect, Corfu, Greece, 13-17 Sep 1976)
2	2:25593	*See* BNL-21864
CONF-760941-		(NRC safety technology meeting on inherent retention, Washington, District of Columbia, United States of America (USA), 21 Sep 1976)
1	2:24742	*See* HEDL-SA-1117
2	2:24743	*See* HEDL-SA-1120
CONF-760942-		(Conference on proton linear accelerator, Ontario, Canada, 14-17 Sep 1976)
7	2:25234	*See* BNL-21800
CONF-760943-		(Conference on nuclear physics with heavy ions, Caen, France, 6-10 Sep 1976)
1	2:25558	*See* LBL-5081
2	2:25582	*See* LBL-5057
CONF-760946-		(Particles and radiation therapy conference, Berkeley, California, United States of America (USA), 15-17 Sep 1976)
5	2:25592	*See* LA-UR-76-2529
CONF-760958-		(3. international symposium of plasma physics on heating in torodial devices, Varenna, Italy, 6-17 Sep 1976)
5	2:25606	*See* COO-2218-69
CONF-760960-		(16. international congress of hematology, Kyoto, Japan, 5-11 Sep 1976)
2	2:25387	*See* BNL-21785
CONF-760964-		(9. international conference on solid state nuclear track detectors, Neuherberg/ Munchen, German, Federal Republic of (F.R. Germany), 30 Sep-6 Oct 1976)
3	2:25246	*See* COO-1671-68
CONF-760967-		(Loss prevention conference, St. Louis, Missouri, United States of America (USA), 27-30 Sep 1976)
1	2:25466	*See* MLM-2365(OP)
CONF-760968-		(National conference on disposal of residues on land, St. Louis, Missouri, United States of America (USA), 13-15 Sep 1976)
1	2:25302	Dep. NTIS, $3.50
CONF-760973-		(International seminar on active processes on the sun and the solar neutrino problem, Leningrad, Union of Soviet Socialist Republics (USSR), 22-24 Sep 1976)
1	2:25489	*See* BNL-21837
CONF-760975-		(Frontiers of power technology conference, Stillwater, Oklahoma, United States of America (USA), 27-28 Sep 1976)
1	2:24855	*See* LA-UR-76-1978
CONF-760981-		(2. symposium on collective methods of acceleration, Moscow, Union of Soviet Socialist Republics (USSR), 29 Sep-2 Oct 1976)
2	2:25236	*See* SAND-76-6037
CONF-760985-		(8. materials research symposium, Gaithersburg, Maryland, United States of America (USA), 20-24 Sep 1976)
1	2:25271	*See* BNL-21946
CONF-760991-		(Nuclear theory conference, Kingston, Canada, 3-4 Sep 1976)
1	2:25542	*See* BNL-21829
CONF-760996-		(Symposium on the neurobehavioral effects of environmental pollutants of the American Psychological Association, Washington, District of Columbia, United States of America (USA), 6 Sep 1976)
1	2:25338	*See* UR-3490-999
CONF-7609106-		(AIME fall meeting, Niagra Falls, New York, United States of America (USA), 20-22 Sep 1976)
1	2:25006	*See* IS-M-87
2	2:25019	Dep. NTIS, $3.50
CONF-7609108-		(Conference on itinerant-electron magnetism, Oxford, United Kingdom of Great Britain and Northern Ireland (UK), 13-17 Sep 1976)
1	2:25027	Dep. NTIS, $4.00
CONF-761002-		(28. southeastern regional meeting of American Chemical Society on biological applications of liquid chromatography, Gatlinburg, Tennessee, United States of America (USA), 27-29 Oct 1976)
5	2:25119	*See* ARH-SA-266
CONF-761003-		(Symposium on atmospheric turbulence, diffusion, and air quality, Raleigh, North Carolina, United States of America (USA), 19-22 Oct 1976)
16	2:25127	*See* BNL-21373
CONF-761006-		(Nuclear science, scintillation and semiconductor counter symposium, New Orleans, Louisiana, United States of America (USA), 20-22 Oct 1976)
25	2:25727	*See* UCRL-78748
28	2:25378	*See* LBL-4797
31	2:25225	*See* LBL-5567
35	2:25243	Dep. NTIS, $3.50
37	2:25249	Dep. NTIS, $3.50
CONF-761007-		(Conference on productivity through instrumentation and control, Houston, Texas, United States of America (USA), 10-14 Oct 1976)
5	2:24423	Dep. NTIS, $3.50
CONF-761008-		(51. annual meeting of the Society of Petroleum Engineers, New Orleans, Louisiana, United States of America (USA), 3-6 Oct 1976)

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6	2:23900	Society of Petroleum Engineers of AIME, Dallas, TX
CONF-761016-	(4. national conference on energy and the environment, Cincinnati, Ohio, United States of America (USA), 5-7 Oct 1976)	
1	2:23956	*See* LA-UR-76-2197
2	2:23951	*See* LA-UR-76-2198
5	2:23901	Dep. NTIS, $3.50
CONF-761023-	(2. ERDA statistical symposium, Oak Ridge, Tennessee, United States of America (USA), 25-27 Oct 1976)	
3	2:24732	*See* BNL-21917
CONF-761027-	(International conference on properties on atomic defects on metals, Argonne, Illinois, United States of America (USA), 18-22 Oct 1976)	
4	2:25500	*See* BNL-21937
5	2:25594	*See* BNL-21938
11	2:25063	*See* COO-3158-52
CONF-761029-	(Society of Exploration Geophysicists conference, Houston, Texas, United States of America (USA), 24-28 Oct 1976)	
1	2:24043	*See* SAND-76-9084
CONF-761037-	(Symposium on target vulnerability and survivability at naval surface weapons center, Silver Springs, North Dakota, United States of America (USA), 26-28 Oct 1976)	
1	2:25585	Dep. NTIS, $3.50
CONF-761042-	(Frontiers in education conference, Tucson, Arizona, United States of America (USA), 25-27 Oct 1976)	
1	2:25625	*See* COO-2218-77
CONF-761045-	(Division of particles and fields conference, Upton, New York, United States of America (USA), 6-8 Oct 1976)	
4	2:25514	*See* COO-2232A-47
CONF-761047-	(The Combustion Institute meeting, LaJolla, California, United States of America (USA), 18 Oct 1976)	
1	2:25169	*See* SAND-76-6246
3	2:24147	Univ. of California, San Diego, LaJolla
4	2:23981	Brigham Young Univ., Provo, UT
CONF-761059-	(4. annual conference on the use of small accelerators, Denton, Texas, United States of America (USA), 25-27 Oct 1976)	
2	2:25586	Dep. NTIS, $3.50
6	2:25496	Dep. NTIS, $3.50
10	2:25501	Dep. NTIS, $3.50
11	2:25505	*See* UCRL-78551
12	2:24052	*See* SAND-76-9100
16	2:25705	Dep. NTIS, $3.50
17	2:25497	Dep. NTIS, $3.50
CONF-761060-	(IAEA symposium on medical radionuclide imaging, Los Angeles, California, United States of America (USA), 25-29 Oct 1976)	
6	2:25377	*See* LBL-4794
7	2:25376	*See* LBL-4785
CONF-761062-	(47. shock and vibration symposium, Albuquerque, New Mexico, United States of America (USA), 19-21 Oct 1976)	
5	2:24521	*See* BNL-21867
CONF-761064-	(8. synthetic pipeline gas symposium, Chicago, Illinois, United States of America (USA), 18-20 Oct 1976)	
4	2:23902	Dep. NTIS, $3.50
CONF-761103-	(ANS winter meeting, Washington, District of Columbia, United States of America (USA), 15-19 Nov 1976)	
18	2:24385	*See* GA-A-14161
24	2:24741	*See* HEDL-SA-877
CONF-761104-	(Conference on mathematical modeling of coal conversion processing, Washington, District of Columbia, United States of America (USA), 16 Nov 1976)	
1	2:23903	Dep. NTIS, $4.00
CONF-761106-	(IEEE international pulsed power conference, Lubbock, Texas, United States of America (USA), 9-11 Nov 1976)	
1	2:25627	*See* SAND-76-5750
CONF-761107-	(Annual meeting of the American Society of Mechanical Engineers, New York, New York, United States of America (USA), 29 Nov-5 Dec 1976)	
22	2:25214	Dep. NTIS, $3.50
23	2:25659	Dep. NTIS, $3.50
CONF-761109-	(69. annual meeting of the AICHE, Chicago, Illinois, United States of America (USA), 28 Nov-2 Dec 1976)	
6	2:23904	Dep. NTIS, $3.50
9	2:24132	*See* UCRL-77981
CONF-761110-	(13. annual meeting of the Society of Engineering Science, Inc., Hampton, Virginia, United States of America (USA), 1-3 Nov 1976)	
2	2:25224	*See* UCRL-78073
3	2:25174	Dep. NTIS, $3.50
CONF-761121-	(Forest and fire meteorology conference, St. Louis, Missouri, United States of America (USA), 16-18 Nov 1976)	
1	2:25283	*See* DP-MS-76-25
2	2:25277	Dep. NTIS, $3.50
CONF-761124-	(7. conference on aerospace and aeronautical meteorology, Melbourne, Florida, United States of America (USA), 16-19 Nov 1976)	
1	2:25290	*See* UCRL-78182
CONF-761127-	(5. IAEA PNE technical meeting, Vienna, Austria, Nov 1976)	
5	2:24508	*See* HEDL-SA-1148
CONF-761129-	(Terrestrial PV measurements workshop, Baton Rouge, Louisiana, United States of America (USA), 10-12 Nov 1976)	
1	2:24171	*See* SAND-76-9142
CONF-761130-	(12. IEEE photovoltaic specialists conference, Baton Rouge, Louisiana, United States of America (USA), 15-18 Nov 1976)	
1	2:24170	*See* SAND-76-5311
3	2:24172	*See* UCRL-76203
CONF-761131-	(Air Pollution Control Association specialty conference, Cambridge, Massachusetts, United States of America (USA), 8-9 Nov 1976)	
1	2:23950	Dep. NTIS, $3.50
CONF-761135-	(American Chemical Society Pacific conference, Phoenix, Arizona, United States of America (USA), 7-10 Nov 1976)	
1	2:24177	*See* SAND-76-5763
CONF-761136-	(ASM conference on manufacture of superconducting materials, Port Chester, New York, United States of America (USA), 8-10 Nov 1976)	
2	2:24319	*See* LA-UR-77-99
CONF-761146-	(IAEA technical committee meeting on radiation damage units, Harwell, United Kingdom of Great Britain and Northern Ireland (UK), 2-3 Nov 1976)	
1	2:25061	Dep. NTIS, $3.50
CONF-761153-	(62. annual meeting of radiologic advances in breast cancer, Chicago, Illinois, United States of America (USA), 15 Nov 1976)	
1	2:25443	Dep. NTIS, $4.00
3	2:25444	Dep. NTIS, $3.50
CONF-761155-	(4. workshop on laser interaction and related plasma phenomena, Troy, New York, United States of America (USA), 8-12 Nov 1976)	
1	2:25621	*See* LA-UR-76-2695
CONF-761202-	(Topical meeting of the Optical Society of America, Williamsburg, Virginia, United States of America (USA), 13-15 Dec 1976)	
2	2:25276	*See* BNWL-SA-5931
CONF-761203-	(2. annual MUSE meeting, Ft. Lauderdale, Florida, United States of America (USA), 6-8 Dec 1976)	
1	2:25717	*See* LA-UR-76-2375
CONF-761209-	(2. international conference of submillimeter waves and their applications, San Juan, Puerto Rico, Dec 1976)	
1	2:25194	*See* LA-UR-76-2076
CONF-761212-	(Symposium on radiation-induced leukemogenesis and related viruses, Bordeaux, France, 7-9 Dec 1976)	
1	2:25437	Dep. NTIS, $3.50
CONF-770101-	(7. symposium on sharing of computer programs and technology in nuclear medicine, Atlanta, Georgia, United States of America (USA), 16-17 Jan 1977)	
1	2:25375	Dep. NTIS, $3.50
CONF-770102-	(Workshop on ceramic and glass radioactive waste forms, Germantown, Maryland, United States of America (USA), 4-5 Jan 1977)	

Report No.	Abstract No.	Availability
1	2:24088	*See* SAND-76-9307
CONF-770103-	(6. world earthquake conference, New Delhi, India, 10-14 Jan 1977)	
1	2:25486	*See* UCRL-78374
3	2:24075	*See* UCRL-78370
4	2:25309	*See* UCRL-78371
6	2:25268	*See* UCRL-78375
CONF-770301-	(173. national meeting of the American Chemical Society, New Orleans, Louisiana, United States of America (USA), 20-25 Mar 1977)	
3	2:23941	*See* BNL-21945
CONF-770304-	(Analysis of nuclear systems, Tucson, Arizona, United States of America (USA), 28-30 Mar 1977)	
4	2:25590	*See* LA-UR-77-59
COO-		
535-763	2:25535	Dep. NTIS, $6.75
1265-183	2:25536	Dep. NTIS, $6.00
1367-75	2:25062	Dep. NTIS, $3.50
1545-181	2:25523	Dep. NTIS, $3.50
1545-196	2:25515	Dep. NTIS, $3.50
1545-199	2:25527	Dep. NTIS, $3.50
1545-200	2:25516	Dep. NTIS, $3.50
1545-201	2:25524	Dep. NTIS, $3.50
1545-202	2:25520	Dep. NTIS, $3.50
1545-203	2:25533	Dep. NTIS, $3.50
1545-205	2:25512	Dep. NTIS, $4.00
1671-68	2:25246	Dep. NTIS, $4.50
2001-14	2:25464	Dep. NTIS, $3.50
2026-32	2:25141	Dep. NTIS, $3.50
2197-43	2:25517	Dep. NTIS, $3.50
2203-5	2:25601	Dep. NTIS, $9.00
2218-69	2:25606	Dep. NTIS, $3.50
2218-70	2:25643	Dep. NTIS, $4.50
2218-77	2:25625	Dep. NTIS, $3.50
2232A-47	2:25514	Dep. NTIS, $4.00
2383-0033	2:25714	Dep. NTIS, $4.50
2383-0034	2:25715	Dep. NTIS, $3.50
2401-67	2:25385	Dep. NTIS, $4.50
2447-5	2:25305	Dep. NTIS, $5.00
2502-8	2:25474	Dep. NTIS, $4.50
2502-10	2:25363	Dep. NTIS, $3.50
2542-4	2:25504	Dep. NTIS, $4.00
2557-1	2:25506	Dep. NTIS, $4.00
2588-1	2:24194	Dep. NTIS, $5.00
2749-15	2:24990	Dep. NTIS, $4.00
2781-5	2:24736	Dep. NTIS, $4.00
2791-2	2:24968	Dep. NTIS, $5.00
2810-2	2:25125	Dep. NTIS, $3.50
2874-3	2:25278	Dep. NTIS, $3.50
2874-4	2:25279	Dep. NTIS, $4.00
2874-6	2:25280	Dep. NTIS, $3.50
2874-9	2:25402	Dep. NTIS, $3.50
2874-10	2:25281	Dep. NTIS, $3.50
2874-11	2:25282	Dep. NTIS, $3.50
2874-14	2:25403	Dep. NTIS, $3.50
2874-15	2:25479	Dep. NTIS, $4.00
2900-6	2:24149	Dep. NTIS, $3.50
2964-1	2:25339	Dep. NTIS, $3.50
3011-6	2:25306	Dep. NTIS, $3.50
3028-27	2:25028	Dep. NTIS, $4.50
3043-26	2:24136	Dep. NTIS, $6.00
3127-16	2:25155	Dep. NTIS, $6.75
3158-52	2:25063	Dep. NTIS, $3.50
3235-77	2:25580	Dep. NTIS, $3.50
4062-2	2:25215	Dep. NTIS, $3.50
COO/2577-		
76/1	2:24195	Dep. NTIS, $5.50
COO/2624-		
76/2	2:24196	Dep. NTIS, $4.50
COO/2628-		
76/1	2:24197	Dep. NTIS, $5.50
CRBRP-ARD-		
0054	2:24424	AT
CRBRP-BCL-		
0160	2:24425	AT
DP-		
1439	2:25253	Dep. NTIS, $6.00
DP-MS-		
76-25	2:25283	Dep. NTIS, $3.50
76-30	2:24141	Dep. NTIS, $4.00
DPST-		
76-128-12	2:24142	Dep. NTIS, $3.50
76-138-4	2:24050	*See* GJBX-6(77)
DPST-LWR-		
76-2-3	2:24066	Dep. NTIS, $7.75
EGG-		
1183-1670	2:24737	Dep. NTIS, $4.00
EPA-		
600/1-76-006	2:25272	Dep. NTIS, $7.75
600/2-76-026	2:25001	*See* PB-254238
EPRI-		
7836	2:25233	Dep. NTIS, $7.50
EPRI-EA-		
316	2:25284	Dep. NTIS, $6.75
331	2:25482	Dep. NTIS, $5.00
EPRI-EL-		
284	2:24309	Dep. NTIS, $9.00
329	2:24317	Dep. NTIS, $4.00
363	2:24314	Dep. NTIS, $4.50
EPRI-EM-		
266	2:24859	Dep. NTIS, $8.00
271	2:24967	Electric Power Research Inst., Palo Alto, CA
335	2:24964	Dep. NTIS, $5.50
336	2:24965	Dep. NTIS, $5.50
EPRI-NP-		
275	2:24738	Dep. NTIS, $6.00
309-SY	2:24679	Dep. NTIS, $4.00
ERDA-		
76-41(11-76)	2:25709	Dep. NTIS, $4.50
76-45-1	2:25484	Dep. NTIS, $4.00
76/146	2:24426	AT
76-159	2:24184	Dep. NTIS, $5.00
77-17	2:24134	Dep. NTIS, $4.00
ERDA/JPL/954355-		
76/11	2:24168	Dep. NTIS, $5.50
ERDA/JPL/954527-		
76/2	2:24169	Dep. NTIS, $4.00
ERDA/NASA/31293-		
76/3	2:24158	Dep. NTIS, $4.50
ERDA-NDC-		
5/L	2:25559	*See* ANL-76-90
ERDA/NSF/00826-		
75/2	2:24293	Dep. NTIS, $7.50
ERDA-tr-		
183	2:23948	Dep. NTIS, $4.50
210	2:25446	Dep. NTIS, $7.75
227	2:25460	Dep. NTIS, $7.50
230	2:24294	Dep. NTIS, $4.00
233	2:24310	Dep. NTIS, $3.50
238	2:25002	Dep. NTIS, $3.50
240	2:25337	Dep. NTIS, $3.50
245	2:24969	Dep. NTIS, $3.50
251	2:24827	Dep. NTIS, $3.50
252	2:24462	Dep. NTIS, $3.50
255	2:24042	Dep. NTIS, $3.50
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2240-5(App.2)	2:23913	Dep. NTIS, $12.75
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FEA/S-		
76/487	2:24920	Federal Energy Administration, Washington, DC
76/488(Vol.2)	2:24921	Federal Energy Administration, Washington, DC

Report No.	Abstract No.	Availability
76/501	2:24922	Federal Energy Administration, Washington, DC
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76/67-EXP	2:25530	Dep. NTIS, $3.50
FES-		
76-2(Vol.1)	2:24920	*See* FEA/S-76/487
76-2(Vol.2)	2:24921	*See* FEA/S-76/488(Vol.2)
76-5	2:24922	*See* FEA/S-76/501
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23-1105-75	2:24960	*See* AD-A-017803
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210/124	2:25377	*See* LBL-4794
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75-7	2:25620	INIS
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199/L	2:25559	*See* ANL-76-90
NEDO-		
20355A	2:24749	General Electric Corp., San Jose, CA

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21220	2:25485	Colorado Geological Survey, Denver, CO, $7.50
21255	2:24166	Dep. NTIS (US Sales Only), $3.50
21264	2:24023	Alaska State Dept. of Natural Resources, Anchorage
21265	2:23962	Alaska State Dept. of Natural Resources, Anchorage
21267	2:24033	Alaska State Dept. of Natural Resources, Anchorage
21268	2:23994	Alaska State Dept. of Natural Resources, Anchorage
21323	2:24020	Bureau of Mines, Washington, DC
21348	2:24031	National Academy of Sciences, Washington, DC
21352/1	2:23957	Radian Corp., Austin, TX
21352/2-4	2:23958	Radian Corp., Austin, TX
21382	2:23991	National Referral Center, Science and Tech., Library of Congress, Washington, DC
21393	2:24198	Dep. NTIS (US Sales Only), $5.00
21425	2:24702	TIC
21427	2:24203	Citizens for Energy Conservation and Solar Development, Inc., Los Angeles, CA
21451	2:24939	Defense Advance Research Project Agency/TAO, Arlington, VA
21625/1	2:24923	Bureau of Land Management, Washington, DC
21625/2	2:24924	Bureau of Land Management, Washington, DC
NRC-		
76-7	2:25658	*See* AEOI-10
NRL-MR-		
3365	2:25697	Dep. NTIS, $3.50
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0035-1	2:24523	*See* PB-250030
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5128-5	2:25546	Dep. NTIS, $4.00
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